THE ENGINEER

A Seven-Day Journal

University Lectures on Nuclear Reactors

A LONDON UNIVERSITY course of thirty lectures devoted entirely to nuclear reactors is to be held in the City and Guilds (Engineering) College, Exhibition Road, London, S.W.7, in October next. The lectures will be given by scientists from the Ministry of Supply's Atomic Energy Research Establishment at Harwell and will embody up-to-date declassified information on reactors, neutron theory, heat transfer, and associated subjects. In the first group of twelve lectures Messrs. F. W. Fenning, D. J. Littler, R. F. Jackson, and R. V. Moore will deal with slow neutron natural uranium reactors, starting with the relevant elementary nuclear physics and its application to the design and control of a simple graphite moderated reactor, and ending with a detailed description of the larger pile at Harwell (BEPO). Particular aspects of various reactors will be the subject of another group of six lectures, by Dr. J. V. Dunworth, Mr. B. L. Goodlet, Dr. H. M. Finniston, Dr. W. G. Marlay, Dr. J. M. Fletcher, and Dr. L. R. Shepherd. A series of three specialised courses will include five lectures for mathematicians on more advanced slow and fast neutron theory by Mr. J. F. Hill and Mr. J. Dodd; five lectures for engineers on heat transfer and reactor design by Mr. J. Diamond, Mr. J. Smith and Mr. R. V. Moore; and a lecture for physicists on the experimental use of a reactor. This lecture will be followed by a practical session, which will give students the opportunity of taking part in experiments involving neutron diffusion and the measurement of a neutron flux, under the supervision of Mr. F. W. Fenning and Mr. P. W. Mummery. To end the course it is proposed to arrange a visit of inspection of the nuclear piles at Harwell and to make provision for informal discussion with the various lecturers. All the lectures are open: they are free to students of the City and Guilds (Engineering) College and to intercollegiate students, but for others fees of ten guineas will cover the whole course, with reduced fees for parts of the course.

Postgraduate Courses in Public Health Engineering

THE second postgraduate course in public health engineering, organised jointly by the Imperial College of Science and Technology and the London School of Hygiene and Tropical Medicine, has recently been completed. Six students from the United Kingdom, Ireland, Egypt, and Pakistan have taken the course, which followed the general lines adopted for the first course. A report on the course, which has been published this week by the Imperial College, says that the public health laboratory in the City and Guilds (Engineering) College was extended during the summer of 1951 and new benches and equipment have been installed. In addition, a laboratory is now available in the London School of Hygiene for training in air sampling, dust counting and other aspects of air hygiene. The courses are planned so that the best use can be made of the facilities offered by the various departments of Imperial College and the London School of Hygiene. For instance, the chemistry, botany, mathematics, and civil engineering departments of Imperial College co-operate in teaching students the chemical, bacteriological, hydrological, and engineering aspects of water supply and treatment, sewage disposal and stream pollution. Tropical hygiene is given special attention for the benefit of students from the Colonies and other overseas countries. The course in this subject, which is given at the Ross Institute of Tropical Hygiene, is preceded by a course in elementary entomology in the zoology department of Imperial College, and followed by a period of field work at the Imperial College field station. Industrial hygiene and air hygiene from the engineer's point of view are dealt with at the London School, where the students are also encouraged to understand the public health importance of the engineer's work. The courses are supplemented by numerous visits to works, and vacation work is arranged to give students practical experience of plant operation. The syllabus for the 1952–53 course has now been prepared, and information concerning it may be obtained from the Deputy Registrar, City and Guilds (Engineering) College, Exhibition Road, London, S.W.7.

The Society of Engineers

THE president of the Society of Engineers, Mr. R. S. V. Barber, has addressed a letter to the members of the Society directing attention to its centenary, which will be celebrated in 1954. Mr. Barber says in his letter that, despite the trend to form specialist institutions, the members of the Society of Engineers to-day represent a true cross section of the engineering profession in all its branches, in civil, mechanical and electrical engineering, and also in the highly specialised fields of radio and aeronautics. For a span of nearly 100 years, the letter continues, the Society has maintained, through periods of war and peace, the aims and objects of its foundation. It has gained in strength through increased membership, but otherwise is little different in structure and in principle of design from that envisaged by its pioneers. The principal object of the Society continues to be the advancement of technical knowledge and the maintenance and improvement of the status of the engineering profession. Mr. Barber emphasises that the celebration of the Society's centenary in 1954 will be a ceremony of appreciation of the efforts of its founders "which cannot be forgotten by all interested in the history of engineering." A committee has been appointed, under the chairmanship of Mr. W. R. Howard, to organise and promote plans for the suitable celebration of the centenary. Suggestions from members of the Society are invited. Mr. Frank Parfett, 17, Victoria Street, London, S.W.1, is the honorary secretary and editor.

British Welding Research Association

THE British Welding Research Association has issued its 1951–52 annual report, which reviews the progress in research made by the engineering, metallurgical and resistance welding committees. The members of council and the Research Board are named and the report comments that the year has been outstanding with regard to the increase in facilities for welding research with the completion of the new laboratory building and its special equipment. The support of the Department of Scientific and Industrial Research in obtaining a grant from E.C.A. funds for purchasing a Kentron hardness testing machine is noted, and also the loan of "Aircomatic" welding equipment from the Ministry of Supply. Satisfaction is expressed by the council that the cost of equipment has been paid out of income, a position made possible only by the response to an appeal for extra funds made by many trade associations. The report briefly mentions the relations with other organisations, the summer school on welding, the welding productivity team, and gives a list of new members. With regard to technical assistance to members, it is thought that it will be helpful if senior research workers are brought more closely into contact with members' problems. A financial statement is included in the report, which goes on to review the research progress of individual committees, including those dealing with ferrous metals, light alloys, engineering and resistance welding, several of which state that work in a particular field has been completed and that the results are being published either as a paper or a report for circulation or in book form. It is stated in the report that the work of the Light Alloys (Metallurgical) Committees has concentrated on welding processes using gas-shielded consumable bare electrodes, and that the engineering committees concerned with fatigue problems have been reorganised to meet the needs of an enlarged research programme. During the year twelve confidential research reports have been circulated to members; their titles are given and also the number of the responsible committee. There is a record of various miscellaneous reports, and of those published in *Welding Research*, the journal of the B.W.R.A., and the report concludes with the names of those serving on the research committees and a list of members, associate members and contributors.

The Institution of Mining Engineers

THE Institution of Mining Engineers states that Mr. J. Cecil Mitcheson has been elected president for 1953–54. He will succeed Mr. R. J. Weeks in January next. Mr. Mitcheson comes of an old mining family, his great-grandfather having worked with George Stephenson at the Old Killingworth colliery. His father, the late George A. Mitcheson, was a well-known mining engineer in the Midlands. Mr. J. C. Mitcheson, who was born in 1898, was educated at Bootham School, the Royal Military Academy at Woolwich, and Birmingham University, where he obtained his B.Sc. degree in mining. During the first world war Mr. Mitcheson held a commission in the Royal Field Artillery. After obtaining his colliery manager's certificate he was appointed lecturer in coal mining and demonstrator in mine rescue at Birmingham University under the late Professor K. Neville Moss. In 1924 Mr. Mitcheson returned to the mining industry to assist his father in his consulting practice in the Midlands and was subsequently appointed managing director of the Birch Coppice Collieries of Morris and Shaw, Ltd. During the second world war he was group production director for the Warwickshire coalfield. When the mines were nationalised Mr. Mitcheson was appointed mining development engineer to the West Midlands Division of the National Coal Board, but he resigned that appointment in the autumn of 1947 to take up consulting work. During his career Mr. Mitcheson has made an extensive study of mining practice in several overseas countries. He has served on the council of the Institution of Mining Engineers since 1943, and from 1943 to 1945 was president of the South Staffordshire and Warwickshire Institute of Mining Engineers.

TACOMA NARROWS BRIDGE UNDER ERECTION

FIG. 13—TRAVELLING DERRICK CRANE MOVING TOWARD MID SPAN

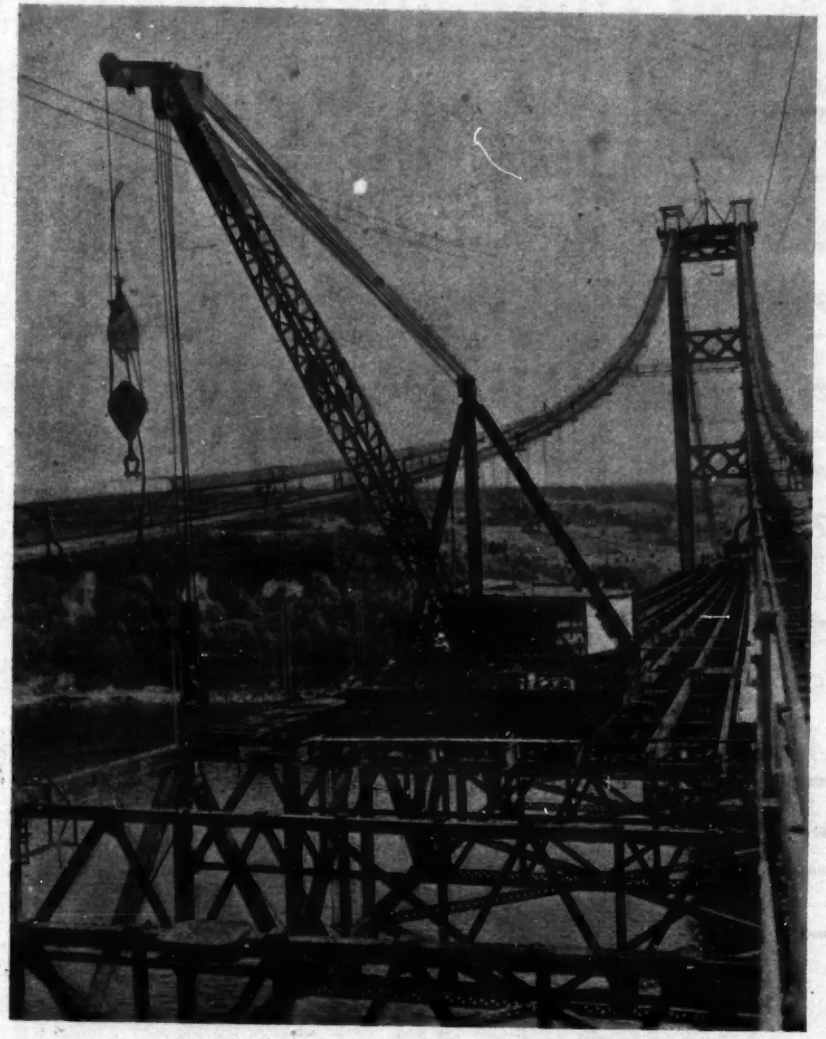


FIG. 14—STEELWORK ERECTION NEAR MID SPAN BY TRAVELLING DERRICK

Tacoma Narrows Bridge

No. II—(*Concluded from page 42, July 11th*)

In an article which appeared in THE ENGINEER *of March 2, 1951, details were given of the design of the new suspension bridge over the Puget Sound, between the city of Tacoma and the Kitsap Peninsula, in the State of Washington, to replace the bridge which was destroyed by a storm in 1940. The following notes deal mainly with the erection of the bridge towers, the spinning of the cables and the erection of the suspended structure.*

Superstructure Erection

THE erection of the suspended roadway steelwork was carried out in three general stages. First, two panels of steelwork were cantilevered out from each side of each tower (Fig. 15) and the four travelling erection derricks, the material bogies, and other erection equipment were set up on these panels. In the second stage, the four travelling derrick cranes erected the rest of the suspended structural steelwork, hanging it from the bridge suspenders. The derricks worked out from the towers, the main span cranes moving towards midspan and the side span cranes moving towards the anchorages. This first pass derrick erection included the entire steelwork except the handrail, the roadway slots, the expansion dams, the maintenance and staging crane rails, and the truss members below the bottom chords adjacent to the towers. On completion of this erection stage the two main span derricks

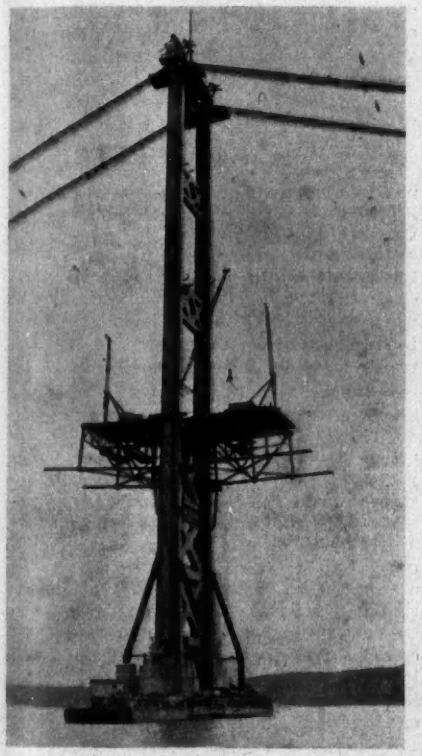


FIG. 15—TWO STEELWORK PANELS CANTILEVERED FROM EACH SIDE OF TOWER

were at mid span and the two side span derricks were at the ends of the side spans. In the third and final erection stage, the travelling derrick cranes made a second pass, erecting those members which had been omitted during the first pass and also a temporary plank roadway. The four derricks worked back towards the towers, finally reaching the points from which they started.

For material handling purposes a boom was attached to the side span face of the south leg of each tower, just above the roadway level. These booms were similar to the ones used during the last stages of tower erection, and were attached and swung in the same manner. A mast height of 70ft was used. A hoist on each pier supplied power to the boom. The booms were used to raise material from barges moored alongside the piers and land it on the material bogies (Fig. 16). Each derrick crane had its own material bogie, which ran on the two roadway stringers to the right of the crane. The capacity of each bogie was 18 tons. Power was provided for each bogie by a two-drum, petrol-driven hoist mounted on the roadway near the tower. The line from one drum was attached to the rear of the bogie and the line from the other drum ran out to the bogie sheave beam at the far end of the erected steelwork, then returned to the front of the bogie. With this arrangement the bogie could be pulled in either direction. The bogie travelled at walking speed and was always accompanied by a flag signalman.

FIG. 16—LOADING OF MATERIAL BOGIE

The four travelling derrick cranes ran directly on the four middle roadway stringers. Each crane underframe consisted of a structural steel platform about 25ft wide and 35ft long. Each corner of this framework was supported by a wheel bogie, which carried two 12in diameter steel wheels mounted in a balancing beam along with two horizontal guide wheels which acted as flanges. This arrangement distributed the wheel bogie reaction equally to the pair of supporting stringers. Each crane underframe carried a small stiffleg derrick with a 23ft mast, a 70ft boom, and a 5ft 6in jib. With the boom straight ahead, the capacity varied between 14 tons at 62ft radius and 7 tons at 70ft radius. The heaviest lifts encountered were truss top chords near mid span, which weighed about 11 tons each. The derrick was reeved with §in wire hoisting rope, with five parts in the main load falls and ten parts in the boom topping falls. Each derrick was operated by a three-drum, 60 h.p. petrol-driven hoist mounted on the crane underframe directly behind the derrick. The maximum line pull was 9200 lb on the first cable layer. The complete travelling derrick weighed about 36 tons. The reactions from all derrick wheel bogies were taken directly into the floor beams. The rear bogies were adjustable in height, so that a level crane platform bed could be maintained as the slope of the roadway changed during erection. The height of a rear bogie was changed by booming out the derrick and hooking on to a floor beam two panels ahead. By taking a strain on the main load, the downward reaction on the rear bogies was relieved. The bolts connecting these bogies to the crane underframe could then be removed and the rear of the crane be raised or lowered by means of the anchored main load falls. Adjustment of the crane platform grade, when required, was always made immediately prior to moving the crane ahead to the next position.

Cantilever steelwork erection was begun on the west tower on November 23, 1949, when cable spinning was about half complete. In the first instance the material handling boom erected the side span double-panel of cantilever steelwork and then erected the main span travelling derrick on it, facing the main span with its mast adjacent to the tower. In this position the derrick boom could reach through the tower to the main span side. This derrick crane then proceeded to erect part of the double panel of cantilever steelwork on the main span face of the tower. It then moved through the tower to panel 38 and completed the erection of the main span cantilever steelwork, erecting the members which it could not reach from its previous position. It then moved ahead one panel to the end of the main span cantilever steelwork. In the meantime the material handling boom had erected the side span travelling derrick at the end of the side span cantilever facing shoreward (Fig. 17). During all these operations the vertical reaction of the cantilever steelwork was taken by the permanent vertical links next to the tower. A pair of temporary horizontal tie-back links held the top chords of the truss to the tower face and a pair of temporary blocking devices took the bottom chord thrust into the tower.

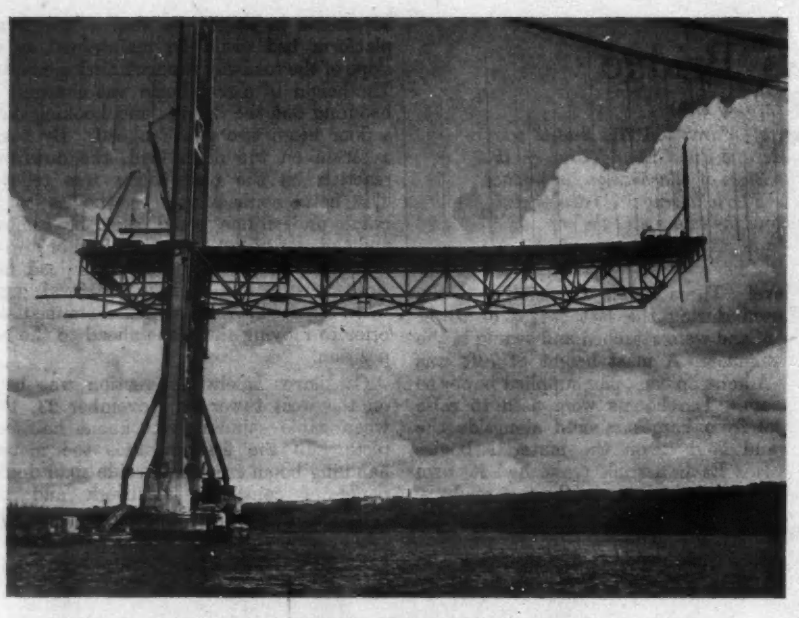


FIG. 17—SIDE SPAN DERRICKS COMMENCING TO ERECT STEELWORK

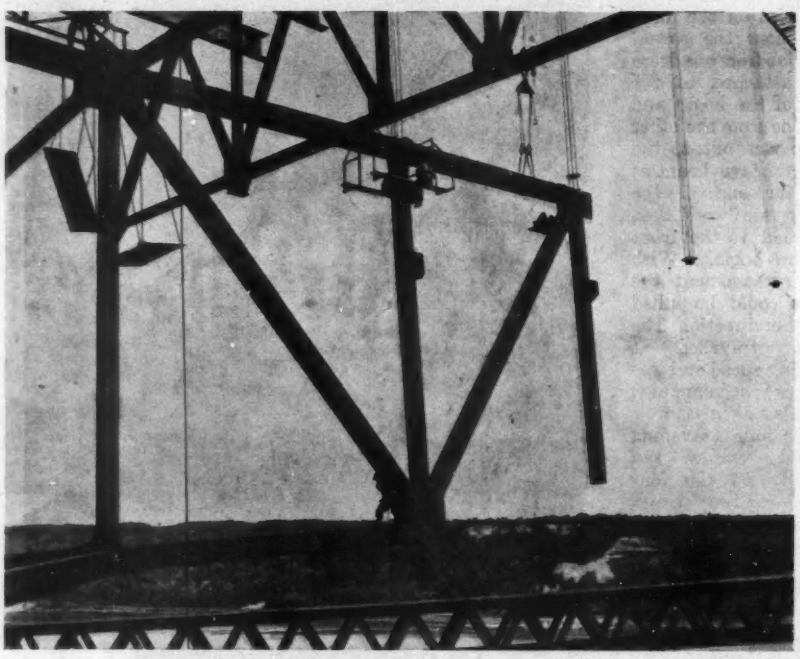


FIG. 18—ERECTION OF A DOUBLE TRUSS PANEL

FIG. 19—POURING DECK CONCRETE NEAR MID SPAN

Cantilever steelwork erection was completed on the west tower on January 26, 1950. On the east tower this work was begun about two weeks after work started on the west tower and was completed on February 3rd. At this time the cable contractor had finished cable spinning and was about to start the cable compacting operation.

The cable contractor turned the cables and suspenders over to the general contractor on March 20, 1950, thus allowing the hanging of the roadway steelwork from the suspenders to be commenced. A 200-ton hydraulic jack, installed within each bottom chord blocking device, was used to remove this blocking and to jack the cantilever panels down on their suspenders. In this manner the cantilever steelwork was transformed into suspended steelwork. At this stage the tower tops had a shoreward deflection of approximately 3ft. The erection of additional steelwork in the side spans at this time would have tended to increase these deflections, which was considered to be undesirable. For this reason only the two main span travelling derricks commenced steelwork erection at the completion of the jacking of the cantilever steelwork. The side span derricks remained at panels 34 until the main span steelwork had been erected as far as panels 49 and the derricks had moved to these points. With the four travelling cranes at panels 34 and 49, each crane had exactly the same number of panels of erection ahead of it prior to the closure of the truss. Thus, delaying the side span operation had the additional advantage of allowing all four cranes to complete their first pass erection at about the same time.

Each main span derrick proceeded to erect a double panel of trusswork ahead of itself, cantilevering it out from the previous trusswork (Fig. 18). Each newly erected truss was then disconnected at the bottom chord splice and raised high enough at its outer end to permit the suspenders to be entered into the connections. The truss unit was then slacked down, placing the suspenders under tension. The truss unit pivoted about the end of its own top chord, which had been connected to the previous chord by only the top splice plates. Consequently, these top plates acted as hinges as the truss unit was raised and lowered. As the first pass of truss erection proceeded, the erected deck steelwork sagged, due to the contour of the main cables under the partial loading. The cables were heavily loaded at and behind the four cranes, but only lightly loaded ahead of the cranes, and the cables deflected accordingly. This caused each truss unit to be kinked upward at its top chord hinge point, leaving an opening of several inches at the bottom chord splice. After the derrick had hung the truss units in the suspenders, it completed erection of the remaining steel in the double panel, then moved ahead to the end of this newly erected steelwork and commenced erection of the next double panel in exactly the same manner.

Once the two main span cranes had moved to panels 49, the two side span cranes began to erect steelwork from panels 34. At the same time the following additional operations were performed :—

(1) The tower erection frames were removed, since they were no longer needed to ensure the stability of the tower base.

(2) The main span top chord tie-back links were cut, transferring the wind stresses directly into the suspenders.

(3) Temporary blocking was installed at the main span wind shoe to prevent the main span steelwork from coasting towerward (since the towers still leaned shoreward).

The four travelling derricks worked simultaneously from stages 34 and 49 respectively, until the final closure of the truss. All four cranes worked at almost exactly the same speed, so that all closure operations were performed at about the same time. When the side span derricks reached panels 24, the side span top chord tie-back links were cut, and wire rope tie-backs were installed between the wind shoe and the side span steelwork to prevent this steel from coasting shoreward.

The bottom chord opening was found to be a maximum immediately after the truss unit was lowered into the suspenders. The maximum bottom chord openings occurred at panels 44, with the derricks at panels 43. These openings measured about 12in horizontally, immediately after the suspenders were loaded. Most of the openings in both main and side spans measured a maximum of about 6in. These openings decreased as the remaining steelwork in the double panel was erected, and decreased further once the crane moved ahead. They continued to decrease as erection progressed, until finally some of the joints began to close. The first joints closed when the cranes were at panels 22 and 61. A week later, with the cranes at panels 18 and 67, all joints were closing rapidly. Once closure was imminent at a joint it was necessary to pull up the end of the cantilever bottom chord so that its sag was removed before it butted into the chord ahead. It would have been difficult to take care of this misalignment after joint closure had taken place.

It was not possible to drive all rivets in a double panel of steelwork immediately after it was erected, because of the general distortion caused by the open bottom chord joints. No joint could be riveted until the joining members were in their normal alignment and the holes were fair. There were about 2000 field rivets in each double panel. Of these, about 700 at the top chord level and about 300 at the bottom chord level could be driven immediately. The remaining rivets could not be driven until the respective bottom chord joints had closed. Prior to the general closure of the bridge truss, riveters followed each derrick crane, driving the rivets which could be driven immediately. These gangs used specially constructed scaffolds to gain access to the top and bottom chord splices and ordinary wood "floats" for access to other joints. After the general truss closure, the gangs made use of the four staging cranes to finish bottom chord riveting. Three of these cranes were supplied as part of the permanent structure for maintenance purposes and the fourth was built specially for erection purposes. Thus, one crane was available for each side span and one for each half of the main span. The riveters worked directly from these cranes, which projected out beyond the trusses on each side. Altogether, there were about 165,000 field rivets and 11,000 field bolts in the suspended bridge roadway. Rivets in the stiffening trusses and lateral systems were 1in in diameter, many of the chord splice rivets being over 7in long. All other rivets were generally $\frac{7}{8}$in in diameter.

The closing top chords in the main span ran from panels 81-west to 81-east, panel point 82 being midspan. The opening between these points was measured and found to be about 9in too short to allow the erection of the closing chords. The wind shoe blocking at each tower was therefore removed, allowing both halves of the main span to swing towerward (the towers still leaned shoreward). One half of the main span was then pulled back another 2in and the closing chord was then erected by both the main span derrick cranes working together. The erection of the remaining closing steelwork followed. Similarly, both side spans had to be pulled towerward several inches before the closing top chords could be erected. All first pass erection was completed on June 5, 1950.

With all first pass steelwork erected the four travelling cranes commenced the second pass erection. This included the installation of the handrail, the expansion dams, the staging and maintenance travelling crane rails, and a temporary plank deck. As a crane completed the erection of each double panel of these miscellaneous items it was moved back a distance of two panels towards the tower. Thus, the crane moves made during the second pass were the reverse of those made during the first pass. Second pass erection was completed on June 20, 1950.

Once the side span travelling cranes had reached panels 34 and completed their erection work from these points, they were dismantled by the material handling booms. The main span cranes, when at panel 38, erected the main span truss members below the bottom chords. Each crane then backed through the tower to panel 36 in the side span and erected the permanent flooring through the tower. Following this, both main span cranes were dismantled by the material handling booms. These booms erected the side span truss members below the bottom chords and assisted in connecting the south suspenders at panels 35 which had been omitted previously to provide clearance for the operation of the booms. Finally, the booms were themselves dismantled by means of the cable contractor's derricks situated at the tower top. This work was completed on the west tower on July 12, 1950, and the corresponding work on the east tower one week later.

The concrete contractor began placing plywood moulds for the pouring of the concrete deck slab late in June, 1950. When this work was well under way the erection of the roadway slots was started. These slots were supported directly on the moulds and were erected by a mobile crane working along the temporary plank deck. The slot sections were about 30ft long and weighed about a ton each. The two outside roadway lanes were poured first, the walkways second, and the inside roadway lanes last. It was not possible to pour the entire slab width continuously, because such a concentration of weight would have seriously overstressed the stiffening trusses. The bridge deck was therefore divided into sixty-six sections, which were poured in such a sequence as to maintain symmetrical weight distribution. The five lines of roadway slots formed convenient boundaries for these pouring sections. The pouring of concrete was begun early in August, 1950, and was completed early in October. The roadway slab was $5\frac{1}{2}$in thick and had a $\frac{1}{2}$in asphalt wearing surface. The lightweight concrete used in the slab weighed about 120 lb per cubic foot and had a twenty-eight-day strength of almost 5000 lb per square inch.

The construction of the second Tacoma Narrows bridge, with the exception of the cable work, was handled by the Bethlehem Pacific Coast Steel Corporation, of San Francisco California. The main structural steelwork was furnished and fabricated by the Bethlehem Steel Company, the work being performed at the company's Pottstown Works. The concrete contractor was Woodworth and Co., of Tacoma, Washington. The cable work was handled by John A. Roebling's Sons Company, of Trenton, New Jersey.

Present-Day Locomotive Working in Great Britain

No. VII*—THE GRESLEY "PACIFICS" ON THE EAST COAST ROUTE

By O. S. NOCK, B.Sc., A.M.I.C.E., M.I.Mech.E.

The day-to-day running of the Gresley "Pacifics" on the L.N.E.R. in the years 1932–39 was an outstanding feature of British locomotive working before the second world war. Extreme difficulties in operation developed during the later years of that war, due to unprecedented loading, and as a result of maintenance troubles the L.N.E.R. decided not to perpetuate the Gresley front end in post-war locomotives. Nevertheless, the Gresley "Pacifics" collectively still continue to do very fine work on the road, and in this article some post-war experiences with the "A 3" class are summarised.

IN the years prior to 1939 locomotive running on the heaviest express passenger trains between King's Cross and Edinburgh had reached a very high standard. The generic "Pacific" design had been developed from the original Gresley type, built for the Great Northern Railway in 1922, to the "A4" streamlined class of 1935; even with train loads exceeding 500 tons behind the tender, speeds of 90 m.p.h. were common on favourable stretches, and no difficulty was experienced in maintaining a booked average speed of 60 m.p.h. over the 105·5 miles from Grantham to King's Cross with trains of 550 tons loaded weight. A booked average of 72½ m.p.h. start to stop was maintained with the 300-ton "Coronation" express over the 188·2 miles between King's Cross and York. There were four stages in the development from 1922 to 1935, as shown in Table I on page 78. This excludes certain prototype engines, such as those used for experimental purposes, when Gresley was considering a change from low to increased boiler pressures. Since the end of the war, in 1945, those engines originally carrying 180 lb boilers have been rebuilt, so that only the "A3" and "A4" classes remain to-day. All are still in service, with the exception of the pioneer Gresley "Pacific" engine "Great Northern," which was used by Mr. E. Thompson, then chief mechanical engineer of the L.N.E.R., for an experimental rebuilding in 1945 to try out a modified front end, in conjunction with a 250 lb boiler. During the war years, when the preoccupation of railway shops with vital munition work made it necessary for locomotives to run for longer periods between general overhaul, to work greater weekly mileages than ever before, and with a minimum of day-to-day maintenance at running sheds, some trouble was experienced with the conjugated valve gear fitted,

* Previous articles in this series were: No. I, "The L.N.E.R. 2-6-2 'Green Arrow' Class," October 11, 1946; No. II, "The L.M.S.R. 'Coronation' Class 'Pacifics,'" December 13 and 20, 1946; No. III, "The G.W.R. Oil-Fired 4-6-0s," February 6 and 13, 1948; No. IV, "The Mixed Traffic 4-6-0s," November 4, 11, 18 and 25, 1949; No. V, "The Western Region 'Castle' Class," April 20 and 27, 1951; No. VI, "First Results from the 'Britannias'," April 4, 1952.

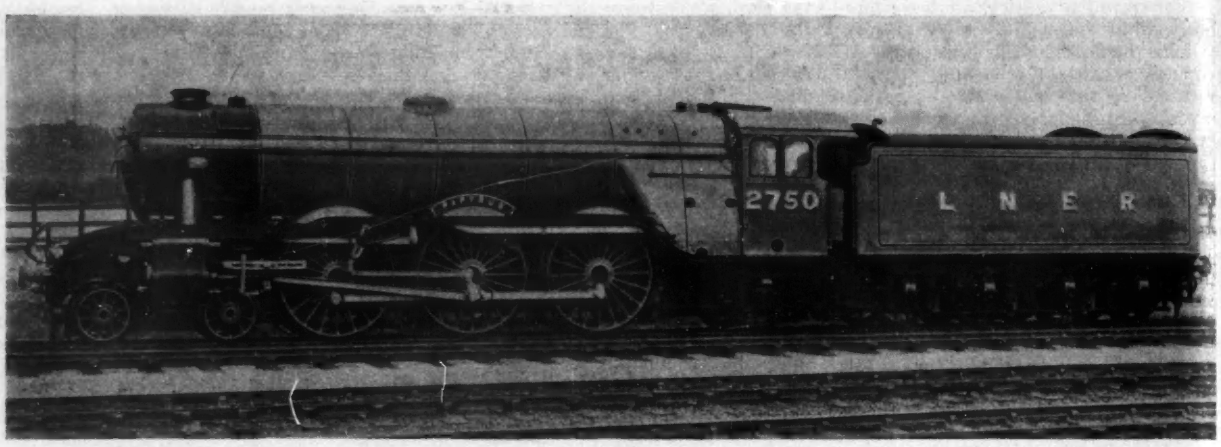


FIG. 1—"A3" CLASS LOCOMOTIVE "PAPYRUS"

not only to the express passenger "Pacifics," but to many other engines of Gresley design; and in laying down the post-war standards which it was intended to follow if the London and North-Eastern Railway had remained an independent company, it was decided to employ not more than two cylinders in all engines of moderate power, and to fit the larger engines, on which three cylinders were needed to provide the required tractive effort, with three separate sets of valve gear.

But although the Gresley "Pacifics," even before nationalisation, represented a series that would not be developed further, with improved standards of maintenance since the war they have retained their place in the top flight of British express locomotives, and it will be recalled that the "A4" class in particular showed up well on coal consumption in the interchange trials of 1948 on all routes where they were run. It is worthy of note also that the summer Anglo-Scottish express running non-stop between London and Edinburgh has been entrusted to the streamlined "A4" engines exclusively since the reintroduction of this service after the war. Operating conditions are now vastly different from those obtaining in the lifetime of Sir Nigel Gresley, when, so far as high speed was concerned, the London and North-Eastern Railway stole much of the Great Western thunder, and indeed set the pace for all England. Nevertheless, in the years since 1945 many remarkable performances have come to my notice, from which an appraisal of the class as a whole has been prepared, including comparisons between maximum pre-war and post-war haulage achievements. These notes are confined to the "A3" and "A4" classes: for although the work of the "A1's" became extremely fine in their modified condition (see stage 2 of Table I), that work is now of historical rather than practical interest. These engines have now all been converted to the "A3" class, and the present "A1's" of Mr. Peppercorn's design are outside the scope of the present article.

CLASS "A3" PERFORMANCE

The leading dimensions of the "A3" class are shown in the accompanying diagram Fig. 2, and what one might expect from them in service on the road can be judged from summary details of four runs timed between 1932 and 1939 (Table II).

The second of the above runs is the fastest yet recorded from a start at King's Cross to passing Peterborough with a load of more than 500 tons. The necessarily slow beginning over the northern heights to Hatfield, was no carefully prepared test run; No. 2507, "Singapore," was commandeered almost at a moment's notice at Newcastle when the booked "A4" engine developed a defect on the run south from Edinburgh and had to be taken off the train.

The graph in Fig. 3 is drawn from a series of indicator diagrams published in a paper read by Mr. B. Spencer before the Institution of Locomotive Engineers in March, 1947; it shows the kind of performance one might expect from an "A3" engine under fairly severe operating conditions. The tonnage of the train concerned was 540, working on level track, and the engine was No. 2751, "Humorist." For ordinary express work on the L.N.E.R. the reverser was usually set at 15 per cent and the regulator kept full open. A typical start, northbound from York on level road, is shown in the diagram Fig. 4;

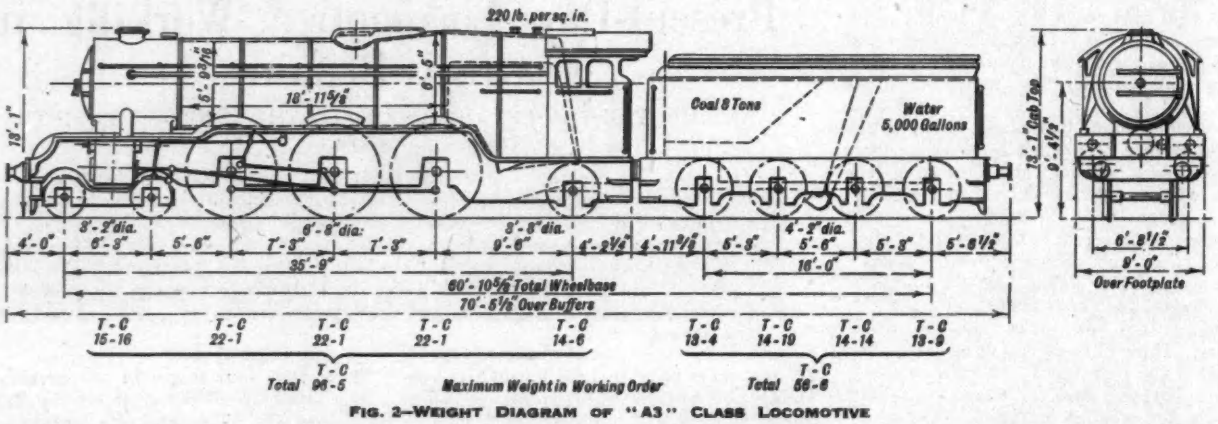


FIG. 2—WEIGHT DIAGRAM OF "A3" CLASS LOCOMOTIVE

17·7 miles in 24¾ min, was followed by some very fast running with a maximum of 87½ m.p.h. and an average of 77·8 m.p.h. over the 27 miles from Hitchin to Huntingdon. The third run was a characteristic, long-sustained feat of heavy load haulage,

TABLE I—*Gresley "Pacific" Development*

Class	"A1" original	"A1" modified	"A3"	"A4"
Coupled wheel diameter	6ft 8in	6ft 8in	6ft 8in	6ft 8in
Cylinders (three):				
Diameter, in	20	20	19	18½
Stroke, in	26	26	26	26
Boiler pressure, lb per sq in	180	180	220	250
Nominal tractive effort at 85 per cent boiler pressure, lb	29,835	29,835	32,909	35,455
Total evaporative heating surface, sq ft	2,930	2,930	2,692	2,576·3
Superheater, sq ft	525	525	703	748·9
Length between tube plates	18ft 11⅛in	18ft 11⅛in	18ft 11⅛in	17ft 11⅛in
Grate area, sq ft	41·25	41·25	41·25	41·25
Motion:				
Piston valve diameter, in	8	8	8	9
Maximum valve travel, in	4⅝	5½	5½*	5½*
Steam lap, outside cylinders, in	1½	1⅛	1⅛	1⅛
Steam lap, inside cylinders, in	1½	1 1/16	1 1/16	1 1/16
Exhaust clearance, in	¼	Nil	Nil	Nil
Lead, in	3/16	¼	¼	¼

* As originally designed, with 65 per cent maximum cut-off. Modified to 6¼in maximum travel, with 75 per cent cut-off in full gear

and the fourth shows what the same engine once achieved on the "Coronation" streamlined train. Moreover, the last-mentioned the load was considerably lighter, totalling no more than 420 tons behind the tender, but the train was accelerated very briskly and the lever had been wound back to 20 per cent cut-off by the first milepost out of York. I have found, however, that the actual reverser reading on these engines should be treated with a certain amount of reserve, quite apart from the tendency for the inside piston valve to overrun at high speed and cause the inside cylinder to develop more than its due share of the power. This characteristic was shown in the indicator diagrams from which Fig. 3 was prepared. The following table shows how the total indicated horsepower was built up in four instances.

Speed, m.p.h.	Cut-off, per cent	Indicated horsepower		
		L.H.	Middle	R.H.
43	30	463	513	527
57	25	460	553	518
63½	20	384	547	472
75	20	402	585	480

To try and avoid troubles arising from this overrunning of the middle piston valve, due to the particular type of conjugated valve gear used, Mr. Peppercorn made some experiments with certain engines of the "A4" streamlined class, lining up the inside cylinder. But the results of these experiments were evidently negative, as no change has been made on the large majority of the Gresley "Pacifics."

The journey, of which the start is shown diagrammatically in Fig. 4, was what might be termed an easy comfortable run made in 1946. The 44·1 miles from York to Darlington were covered in 46 min start to stop, and the 36 miles on to Newcastle in 45½ min with very cautious running through Durham, and restrained speed downhill from Chester-le-Street. Shortly after the war, however, a much more severe test of an "A3" engine, on the steeply graded route through the Border country, was noted between Carlisle and Edinburgh. In recovering time from a late start engine No. 2747, "Coronach," was run with regulator full open and 27 per cent cut-off for a period of 14 min, during which speed averaged 51½ m.p.h. up the gradual incline from Galashiels to the summit point just 18 miles short of Edinburgh, at Falahill signalbox, 880ft above sea level. The engine working suggests a continuous output of about 1500 i.h.p.; steam pressure was constantly maintained, though there was plenty of noise from the exhaust. The working of this engine had, however, been less impressive earlier in the same run during the ascent of the long gruelling incline from Newcastleton up the northern flanks of Liddesdale to Whitrope summit, in the Cheviots, where the gradient is 1 in 75 continuously for 9¼ miles. The alignment is curving for many miles, but from a start at Newcastleton we took 20 min 54 sec to pass Whitrope, 10·3 miles, even though the load was no more than 275 tons. Cut-off was 26 per cent, with full regulator throughout, yet the curving stretch through Riccarton Junction brought us down at one point as low as 24½ m.p.h. Clearly the engine could have been worked much harder, if it had been necessary, without approaching the steaming rate successfully maintained northward from Galashiels; but in my own experience these "Pacifics," and not less those of L.M.S. design, are prone to slip on the heaviest gradients if one should try to steam them really hard, and in consequence their day-to-day work on the banks of the Scottish lowlands is generally inferior to what perhaps one might expect from their proportions.

The Gresley "Pacifics" seem to be at their best in the haulage of heavy trains over a relatively easy road. Since the war, when train schedules over the East Coast route have remained below their pre-war level, engines of the Gresley "A3" and "A4" classes, and the new "A1" class of Peppercorn design seem to have been used almost indiscriminately on heavy trains between King's Cross and Newcastle, including duties on which the one engine works throughout the 268·3 miles. A few examples of "A3" performance since nationalisation may be quoted (Table III).

On all the above post-war runs booked time was kept, or slightly improved upon; but there were others, as, for example, the continuation of No. 7 run forward to King's Cross, when the locomotive showed signs of being short of steam. Runs 4, 5 and 6 were successive parts of the same journey, but with a different engine crew on each stage. There was some fine work on runs 1 and 4, with examples of that pre-war ability to work train loads of more than 500 tons at 70 m.p.h. and over on level track.

The overall performance of the Gresley "Pacifics" to-day, and particularly that of the "A3" class, which include so many features that were incorporated in the epoch-making original Great Northern Railway engines of 1922, is of unusual interest as showing how this design is standing up to conditions of operation and maintenance that were not contemplated thirty years ago. Taken all round, these engines, now almost

TABLE II—*Four Runs Between 1932 and 1939*

Route	Engine		Load, tons gross	Miles	Time		Net average speed, m.p.h.
	No.	Name			Actual, min sec	Net, min	
1. Grantham-Doncaster	2503	"Firdausi"	420	51	51 25*	46	66·5*
2. King's Cross-Peterborough ...	2744	"Grand Parade" ...	530	76·4	73 55†	74	62·0†
3. York-King's Cross...	2507	"Singapore"	540	188·2	195 21*	189½	59·5*
4. Newcastle-King's Cross ...	2507	"Singapore"	290	268·3	227½*	222½	72·2*

* Start to stop. † Start to pass

TABLE III—*Some "A3" Runs Since Nationalisation*

Route	Engine		Load, tons gross behind tender	Miles	Time		Net average speed, m.p.h.
	No.	Name			Actual, min sec	Net, min	
1. King's Cross-Grantham...	60,039	"Sandwich"	530	105·5	120 03	117	54·1
2. Darlington-Grantham ...	60,083	"Sir Hugo"	525	126·8	144 12	140	54·3
3. York-Darlington	60,084	"Trigo"	395	44·1	47 04	44	60·0
4. King's Cross-Grantham...	60,110	"Robert the Devil" ...	495	105·5	119 48	117	54·1
5. Grantham-York	60,110	"Robert the Devil" ...	495	82·7	98 35	95	52·2
6. York-Darlington	60,110	"Robert the Devil" ...	420	44·1	47 06	47	56·3
7. York-Grantham	60,047	"Donovan"	465	82·7	98 10	94	52·8
8. Newcastle-Edinburgh ...	60,036	"Colombo"...	385	124·4	135 20	129½	57·7

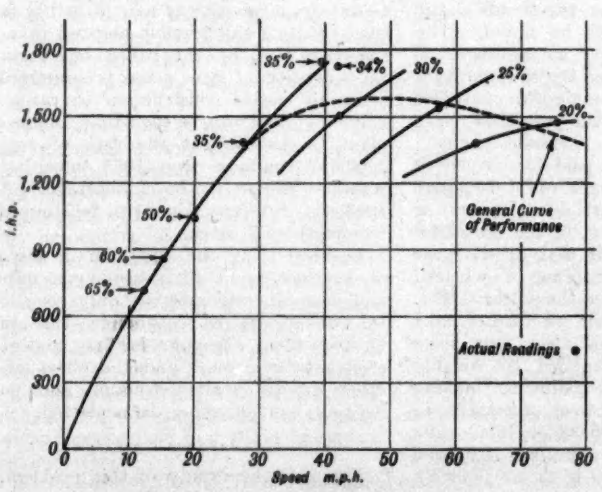


FIG. 3—PERFORMANCE OF ENGINE 2751, CLASS "A3"

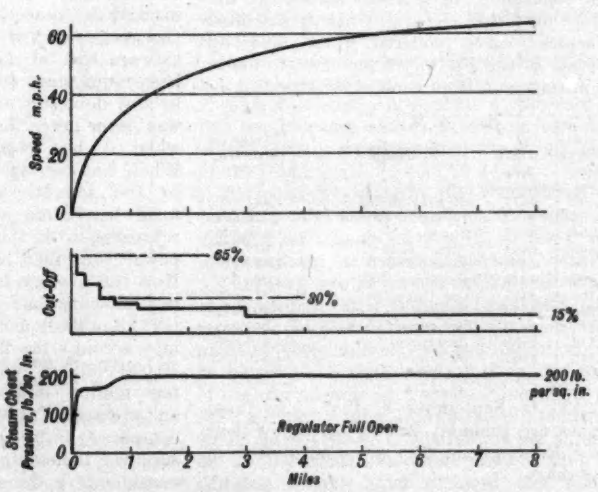


FIG. 4—ENGINE 2577 "NIGHT HAWK"—LOAD 420 TONS

old enough to be called veterans, are still taking a noble part in East Coast express haulage. An impression formed, however, after a number of footplate experiences since the war, is that they are susceptible, to a degree rather more than many of their contemporaries, to the attention, or lack of it, that they receive at running sheds. A Gresley "Pacific" with the conjugated valve motion out of adjustment through worn pins, with play in the axleboxes, and "slogger" on the big-end brasses, can be a fearsome animal to ride upon, just as a well-tuned-up engine of the same class can be one of the sweetest and most enjoyable. On my footplate journeys the steaming has been generally good even on one particularly memorable engine that was in a truly shocking condition mechanically, but which was coaxed and pounded over the road with such resolution by the crew that no time was lost.

A performance noted in the early spring of 1951 on the Anglo-Scottish express leaving Edinburgh at 2 p.m. indicates the quality of work which the "A3" class regularly put up in pre-war years and which they can still perform to-day when properly tuned up. At the time of this trip the train was allowed 67 min start to stop for the 57·5 miles from Edinburgh to Berwick, and 75 min for the 66·9 miles forward to Newcastle. Berwick was reached in an actual time of 63 min 22 sec, but the approach to Newcastle was delayed after the 61·9 miles from Berwick to Forest Hall had been covered in 65 min. Some details of this fine run are given in the accompanying table.

Engine	Class "A3," No. 60099, "Call Boy"
Load, gross tons behind the tender ...	405
Total distance	124·4 miles
Total aggregate net running time	132½ min
Average speed	56·4 m.p.h.
Total journey time	147½ min
Time that main regulator was open ...	95½ min
Cut-off during main regulator steaming :	
Between 14 and 15 per cent	45 min
Between 18 and 20 per cent	20 min
Between 21 and 28 per cent	30 min

The last-mentioned condition of working included 15 min continuously, between 24 and 30 per cent while speed was regained following a permanent way slack just south of Dunbar, while she worked up to 62 m.p.h. in readiness for the Cockburnspath bank, and then during the ascent of the bank itself, prior to which cut-off was advanced to 26 per cent while still travelling at 60 m.p.h. The 4¼ miles of 1 in 96 gradient were climbed at a minimum speed of 35 m.p.h., working in 28 per cent cut-off. During the ascent steam pressure was maintained at 220 lb per square inch.

In conclusion, to indicate the service the oldest of the Gresley non-streamlined "Pacifics" have rendered, I am able, by courtesy of the Railway Executive, to quote the mileage run from time of construction in 1922–23 to September 8, 1951. As these engines are probably known better by their L.N.E.R. numbers, they are also quoted in the table.

British Railways No.	L.N.E.R. No.	Name	Mileage to Sept. 8th, 1951
60,102	4471	"Sir Frederick Banbury"	1,441,330
60,103	4472	"Flying Scotsman" ...	1,528,321
60,104	4473	"Solario"	1,496,906
60,105	4474	"Victor Wild"	1,627,707
60,106	4475	"Flying Fox"	1,620,128
60,107	4476	"Royal Lancer"	1,640,312
60,108	4477	"Gay Crusader"	1,517,406
60,109	4478	"Hermit"	1,607,382
60,110	4479	"Robert the Devil" ...	1,551,989
60,111	4480	"Enterprise"	1,401,080
60,112	4481	"St. Simon"	1,430,195

(To be continued)

Plan for Electricity

By G. K. ALSTON, B.Sc.(Eng.), M.I.E.E.

In this Chairman's Inaugural Address (hitherto unpublished) to the North Lancashire Sub-Centre of the Institution of Electrical Engineers, presented in October last year, the author concisely presents the arguments for encouraging industry to install heat-electricity generating plants and for the wide extension of district heating on the grounds not only of a saving in coal burnt, but also of capital expenditure.

IN the United States of America, new electricity generating plant is being installed at the rate of 6500MW per annum. The highest rate of plant installation in this country at present programmed is rather less than 1500MW. Comparing the populations of the two countries, to keep pace with industrial expansion and the domestic and commercial demand for electricity, Britain needs to install not less than 2000MW per year. Additionally, to compare with industrial mechanisation in the United States, it will be necessary to double the use of horsepower in industry. This cannot be done at once, and it means that, to achieve such greater mechanisation, the programme for new plant must be appreciably higher than 2000MW per annum.

Shortage of Statistics

Any study of the electricity supply situation, with a view to the formulation of future plans, immediately reveals the shortage of statistics. Accurate figures for the quantity of electricity consumed in kilowatt-hours for the various main consumer classes exist over a sufficient period to provide a reliable indication of the future trend. but corresponding information on demand in kilowatts is almost entirely absent. Before any real study of the problem is possible it is essential that a fairly accurate assessment be made of the main components of the demand on the electricity supply system during the mid-winter period. This involves a good deal of guess work and the results cannot be more than an approximation, due to the shortage of information. The magnitude of the problem is, however, so great that minor inaccuracies are of relatively little importance, as will be seen from the information to be presented later.

The Present Position and Future Trend

The growth in the nation-wide use of electricity and the variation in price are shown in Fig. 1, illustrating the comparison between the consumption of electricity for lighting, heating and cooking by the domestic and commercial consumer on the one hand, and the use for power by the industrial consumer on the other hand. The very marked difference between the trends of the two price curves should be noted. The average cost of electricity to industry has been rising since 1937, but the average price to the domestic and commercial consumer was never lower than in the year 1947, since when it has begun to increase slightly. When the average price paid for electricity by the domestic consumer on a two-part tariff (excluding commercial consumers) is compared with that paid by the industrial power consumer, we find that in the year 1948 the average for the former was 1·13d. per kilowatt-hour and for the latter 0·93d. per kilowatt-hour. When we further take into account the fact that there were some 12,000 million units supplied to roughly ten million domestic consumers, making an average of 1200kWh per consumer, as compared with some 20,000 million units supplied to less than 0·2 million industrial consumers, making more than 100,000kWh per consumer, we see that the cost of electricity in each case does not bear proper economic comparison. The very low price of electricity to the domestic consumer has encouraged the increased use of electricity at a time when economy was of the utmost importance.

The mean rate of increase in domestic and commercial consumption over the period

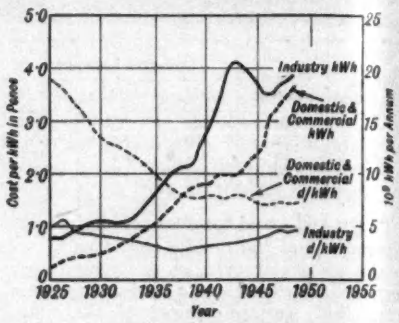


FIG. 1—CONSUMPTION AND COST OF ELECTRICITY, 1925–1948

1925–49 was 11·6- per cent geometrical progression, as compared with 8·6 per cent for total consumption.

Fig. 2 shows the growth in the nation's demand for electricity and the quantity of plant installed in central power stations to meet it. The variation in ratio of these two quantities is also shown. The dangerous reduction in the ratio has been well evidenced by our load-shedding experiences of the last few years. The natural rate of increase in demand was appreciably disturbed by the war, but, from 1925 to 1938, it followed a geometrical progression of 9 per cent per annum. From 1925 to 1950, the mean rate of increase has been 6·8 per cent per annum. It is not unreasonable, therefore, to assume that, unhindered, the rate of increase from now on will be of the order of 6·8 per cent geometrical progression, and it may even be higher.

Fig. 3 is a projection of Fig. 2 into the future, showing the increase in plant capacity planned by the B.E.A., the plant availability based on this up to 1955, and the future demand if it maintains a geometrical progression of 6·8 per cent per annum. The actual commissioning of new plant has fallen so far behind the amount planned that, for the years 1953–54, the B.E.A. has curtailed the quantity of new plant programmed in order to enable construction to catch up. From Fig. 3 it can be seen that, unless new plant is installed at the rate of roughly 2000MW annually, from 1955 onward there would continue to be a shortage. After 1963, this rate would need to be stepped up to something greater.

In illustrating the variation in the cost of electricity and the increase in consumption and demand, reference has only been made to two groups of consumers, but these, between them, account for 96 per cent of the electricity consumed and the effect of the other groups, mainly traction and public lighting, can, therefore, be neglected.

Analysis of Load

For a further study of this problem, we must now form some idea of the make-up

of the mid-winter demand on the nation's power system. In order to do this, a careful comparison has been made between summer and winter load curves in conjunction with a study of unit consumption by domestic, commercial and industrial consumers and published data based on load sampling. From these considerations, Fig. 4 has been prepared, which it is believed fairly represents the conditions of demand during the mid-winter period 1949–50. Incidentally, this demand exceeded the available plant capacity by roughly 1000MW.

Having subdivided the demand curve into industrial, domestic and commercial components, it is necessary to consider what comprises each of these loads. Industrial

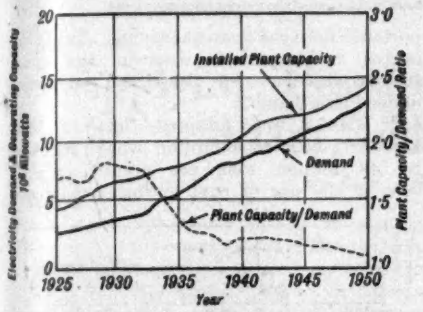


FIG. 2—GENERATING CAPACITY AND DEMAND 1925–1950

demand is almost entirely for motive power for which there is no practical alternative to electricity. Where it is used in other ways, as for melting and heat-treatment in the metals industries, electro-chemical processes and welding, it is equally essential. It is safe to say that the industrial use of electricity for space heating is too small to influence the present considerations.

The domestic use of electricity presents a very different picture. It is well known that the severity of the weather has a pronounced effect on space heating loads and the 44 per cent, which is a mean winter value for space heating in weather colder than average, can become at least 60 per cent—Table I. A recommendation will be made later that this load, and the water heating load, would

TABLE I—*Domestic Electricity Demand*

	Percentage of mid-winter demand	
	Mid-summer	Mid-winter
Constant loads :		
Cooking	20	20
Water heating	12	12
Variable loads :		
Lighting...	5	19
Space heating	—	44
Total	37	95

better be served by district heating. The other uses of electricity in the home are so well justified and established that no good case can be made for an alternative at present.

The mid-winter use of electricity in commercial premises is very similar in characteristic to the domestic use, except that lighting plays a much greater part. Consequently, space and water heating combined roughly amount to 50 per cent of the load in colder than average weather, compared with approximately 70 per cent for domestic premises. Again, it is to be recommended that use be made of district heating.

Figs. 5 and 6 reproduce the domestic and commercial demand curves from Fig. 4 and show the space and water heating proportions of the load. Fig. 7 shows the combined space and water heating load that could be served by district heating.

As in the case of the domestic and commercial loads, the industrial demand on the national supply system offers scope for reduction. According to Ministry of Fuel and Power statistics, "Engineering Industry," "Other Industries" and "Non-Industrial Establishments" use 38 million tons of coal annually. Investigation indicates that at least 20 million tons are used for space or relatively low-grade process heating, and, further, that during normal mid-winter daytime working hours fuel is being consumed for these purposes at the rate of roughly 5000 tons per hour. This same quantity of fuel, used in suitably designed heat-electricity generating plants, would provide the present heating requirements and also an output of 4000MW of electricity.

FUTURE PLAN

There is little question that district heating and industrial heat-electricity generation are technically possible and the case for or against each would appear to rest on economic considerations. A future "Plan for Electricity" might be any one of the following :—

(1) A limited increase in national generating capacity with curtailment of supplies by high prices, shedding, ripple control or similar measures.

(2) An unlimited increase in generating capacity to meet all demands.

(3) A reduction of demand by supplying certain sections of the load from more economic sources and an increase in national generating capacity sufficient to meet the balance of the load.

It is proposed to reject Plan 1 as unsocial and to draw comparisons between 2 and 3 with a view to establishing a case for Plan 3.

PLAN 2

In the ten years 1955 to 1965, 20,000MW of new plant would be needed to meet an unhindered increase in demand and to take the place of old plant falling out of service. At an estimated cost of £100 per kilowatt for new generation, transmission and distribution equipment, a capital investment of £2000 million is involved. If this is to be paid for by the consumer, the price of electricity must appreciably increase.

In the period 1930 to 1950, the consumption of coal for the generation of electricity increased at the rate of 6·6 per cent geometrical progression. This compares with 8·6 per cent for electricity generated and

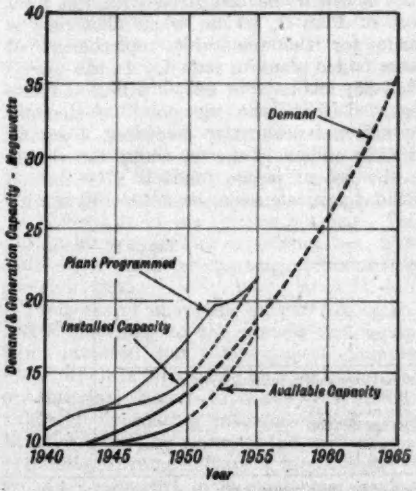


FIG. 3—FUTURE GENERATING PLANT CAPACITY AND DEMAND

shows the effect of improved thermal efficiency. It is probable that the future rate of fuel increase will be nearer to that for units generated but, even using the lower figure of 6·6 per cent, the annual fuel consumption in 1965 would be 78 million tons.

PLAN 3

Plan 3 is now considered under three headings :

(*a*) Industrial power plant.

(*b*) District heating.

(*c*) Additional central power stations.

Section (a).—It has already been stated that if 20 out of the 38 million tons of coal used in general industry were used for combined heat-electricity generation, industry would, in mid-winter, be able to provide about 4000MW of electricity. This represents conditions as in 1949–50, and if the demand increase year by year follows the same trend as the national demand curve, by 1955 the available capacity would be 5600MW and, by 1965, 10,800MW. This presupposes that heat demand in industry will increase at the same rate as electricity demand, which is probably not the case. For greater safety, therefore, it is assumed that a total of 6000MW of plant could be brought into use in industry over the period 1955–65 at a uniform rate of 600MW per annum. The cost of this, with new boiler plant of suitable pressure and output for factory conditions, is estimated to be £120 per combined kilowatt

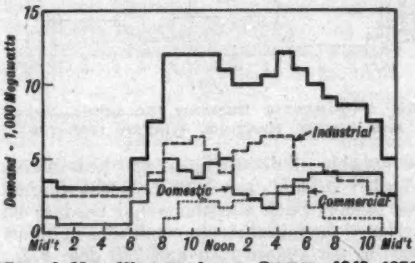


FIG. 4—MID WINTER LOAD CURVE, 1949–1950

of plant and 25 lb per hour of boiler capacity, or a total of £720 million for the ten-year programme. With 6000MW of plant installed industry would, in 1965, be generating 24,000 million kWh, saving £44 million per annum on its electricity bill, and the nation would be saving 14 million tons of coal each year. It has been assumed that the installation of new plant would enable industry to meet its heating loads and generate the electricity without any increase in fuel demand. This is reasonable, since modern water-tube boilers would in almost all cases replace much less efficient shell-type boilers. In all probability there would be a reduction in fuel consumed by the industries involved.

The capital cost of Plan 3, Section (*a*) is high, but the benefits are also considerable. As an inducement to industry to install heat-electricity generating plant, the Government should :—

(i) Subsidise the new plant at the rate of £80 per kilowatt ; or

(ii) Subsidise the new plant at the rate of £40 per kilowatt and exempt from taxation all the savings resulting from the installation of the plant.

For economy, standby plant would not be installed and facilities should exist for drawing on the public supply, in the event of breakdown, at a reasonable tariff. Under (i), industry would have a net annual return of £22 million (after deducting tax) and have replaced obsolete boiler plant, for an investment of £240 million, and the nation would be better off to the extent of 14 million tons of coal per annum for a capital investment of £480 million. Under alternative (ii), industry would have a return of £44 million per annum on an investment of £480 million, and in addition would have renewed old boiler

plant; the nation would have saved 14 million tons of coal per annum for a capital investment of £240 million.

During the period 1955–65 it is inevitable that a proportion of industrial boiler plant would need replacement and the value of such replacement might reasonably be taken as £40 million.

Section (b).—Fig. 7 shows the domestic and commercial heating demand that might be met by district heating. Whilst it presents many formidable difficulties, every effort should be made to introduce district heating from heat-electricity stations on as wide a scale as possible, using some of the heat now being poured from central power stations into rivers and the atmosphere at the rate of 16 million tons a year. When the 1955 programme for new central station plant is complete this loss will have increased to 22 million tons of coal each year and by 1965 would reach 41 million tons.

From Fig. 7 we see that there is a maximum heat demand of 3500MW, though, as previously mentioned, in extremely cold weather the demand is much higher. Heat-electricity stations to provide this quantity of heat in the form of hot water, assuming a distribution heat loss of 30 per cent, would need to

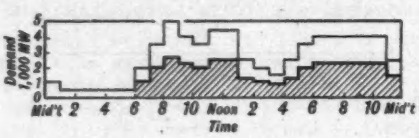


FIG. 5—DOMESTIC DEMAND INCLUDING SPACE AND WATER HEATING, WINTER 1949–1950

be capable of delivering to the heat mains 17×10^9 B.Th.U. per hour (170,000 therms per hour). Such stations would need to be designed for initial steam conditions of about 800 lb per square inch and 780 deg. Fah., and a turbine exhaust pressure of 0/10 lb per square inch gauge. Under these conditions the stations would generate 1350MW of electricity in addition to providing the heat equivalent of 3500MW. The boiler capacity would be 18·3 million pounds per hour. The cost of the stations is estimated at roughly £100 million and of the distribution system for district heating £70 million, i.e., a total cost of £170 million. The fuel consumption of such stations, delivering a useful 3500MW of heat and a useful 1200MW of electricity (1350MW less 150MW used for pumping and station auxiliaries) would be 1162 tons per hour. Conventional condensing stations, to generate 4700MW (3500MW of heat and 1200MW of electricity) would consume, at 1·30 lb per kilowatt-hour, 2730 tons per hour, or 2·3 times as much as the heat-electric stations.

If it is assumed that the domestic and commercial heat demand will expand at the same rate as the electricity demand, 6·8 per cent G.P., then by 1965 the 1950 heat load of 17×10^9 B.Th.U. per hour would have increased to 46×10^9 B.Th.U. per hour and the electricity, generated as a "by-product," from 1200MW to 3200MW. Combining these quantities, the increase would be from 4700MW equivalent in 1950 to 12,600MW in 1965. The corresponding increase in fuel consumption would be to a figure of 3120 tons per hour at maximum load. With an annual load factor of 30 per cent, the coal consumed in the year 1965 would be 8·2 million tons. The cost of stations to deliver 46×10^9 B.Th.U. per hour and 3200MW, would be £460 million.

New heating systems would need to be installed in houses, offices and shops and these would involve a high capital expenditure, particularly in existing premises, unless there was suitably adaptable hot water heating already installed. In new houses, of which millions still need to be built, the adoption of hot water heating would show an economy in building costs by comparison with the provision of fireplaces and chimneys. In this case the cost should present no difficulty. To set against the capital cost of the heating installations there would be a saving of at least 40 per cent on the equivalent electricity bill for space and water heating.

Section (c).—Plan 3, Sections (*a*) and (*b*) have provided new generating capacity in the shape of industrial heat-electric stations and district heat-electric stations,

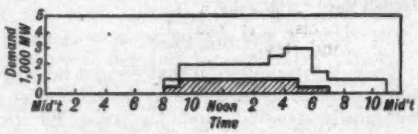


FIG. 6—COMMERCIAL DEMAND INCLUDING SPACE AND WATER HEATING, WINTER 1949–1950

equivalent respectively to 6000MW and 12,600MW by 1965. This combined new capacity would meet 18,600MW out of the 20,000MW needed under Plan 2, leaving a balance of only 1400MW of new plant to be installed between 1955 and 1965. To provide a safety margin, however, 4000 would be installed. This would enable standby plant to be available to meet failures in the industrial and district heat-electric plants. The cost of 4000MW of conventional new condensing plant, with proportional transmission and distribution, would be £400 million.

Capital Cost.—The capital cost of Plan 3 is set out in Table II.

The totals in Table II for the cost of

TABLE II—*Capital Cost of Plan 3*

Section	Capital cost, £ million		
	Gross	To the nation	
		Without tax remission	With tax remission
(*a*) ...	720	480	240
(*b*) ...	460	460	460
(*c*)... ...	400	400	400
Total ...	1580	1340	1100

Plan 3 are to be compared with the total cost of Plan 2, which, when allowance is made for the inevitable replacement of some boiler plant in industry in the period 1955–65, amounts to £2040 million. When regarded from the viewpoint of demand on national productive resources, a saving of £460 million is shown, whilst the saving in the use of public funds is £700 million without tax remission, or £940 million with tax remission. The larger of these savings is more than sufficient to finance the Ministry of Fuel and Power's 1950–65 "Plan for Coal," estimated to cost £520 million and produce an extra 40 million tons of coal per year.

Fuel Consumption.—The fuel saving to be credited to Plan 3 is probably of greater importance than the financial saving. Table III makes a comparison between the total fuel requirements for electricity generation under Plans 2 and 3.

TABLE III—*Annual Fuel Consumption for Electricity Generation*

	Millions of tons		
	Plan 2	Plan 3	Saving due to Plan 3
Existing plant (1949–1950) ...	30	30	—
Additional required in 1955	11	11	—
Further addition required in 1965	37	12*	25
Total	78	53	25

* $3\cdot8\times10^6$ tons for new condensing plant and $8\cdot2\times10^4$ tons for heat-electric district heating plants.

If Plan 2 were adopted, between 1950 and 1965 coal consumption would increase by 48 million tons per annum, which, even if the use of coal for other purposes

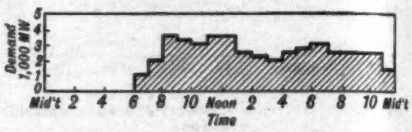


FIG. 7—COMBINED SPACE AND WATER HEATING DEMANDS, WINTER 1949–1950

remained unchanged, would be more than the 40 million tons the Ministry of Fuel and Power's "Plan for Coal" would provide. Plan 3 shows an increase of only 23 million tons over the same period, leaving a margin of 17 million tons for other uses, including export.

UNIT COST

Under Plan 2 the average unit price of electricity, allowing only for increased capital charges, would be 1·25d. per kilowatt-hour. This assumes that the cost of coal, repairs, wages and administration remains at the present rate. Under Plan 3, Section (*a*), the saving to industry has already been given as £44 million per annum, the unit cost of the 24,000 million kWh that would be generated in 1965 being 0·81d. per kilowatt-hour. Under Plan 3, Section (*b*) (District Heating) on the basis of charging half the capital cost to heat supplies and half to electricity supplies, the cost of heat and electricity in 1965 would be as follows:—

Cost of heating, measured in kWh ... 0·73d.
Cost of electricity, per kWh ... ... 1·07d. } 0·83d.

This again assumes no change in costs other than capital charges and excludes Section (*a*) (Industrial Heat-Electric Stations) and Section (*c*) (Additional Condensing

TABLE IV—*Financial Comparison, Plans 2 and 3*

	Plan 2	Plan 3			
		Plant installed up to 1955	Section (*a*)	Section (*b*)	Section (*c*)	Totals combined plant
Annual electricity, million kWh:						
1950	41,000	41,000	—	—	—	41,000
Extra in 1955	21,000	21,000	—	—	—	21,000
Extra in 1965	76,000	—	24,000	36,000*	16,000	76,000
Total in 1965	138,000	62,000	24,000	36,000	16,000	138,000
Unit cost, 1965, pence/kWh...	1·25	1·25	0·81†	0·83	1·25	1·06
Total annual cost 1965, £ million...	720	323	81	125	84	613
Annual saving 1965, relative to plan 2, £ million	—	—	44	63	—	107

* Heat and electricity combined; (27×10^3) kWh heat and (9×10^3) kWh of electricity.
† Based on capital cost of £720 million less £120 million chargeable to boiler renewals.

Stations). It is interesting to note that the unit cost for electricity compares closely with that for the overall cost of electricity (1·06) under Plan 3, and this simplifies any problem on deciding the price to charge. The cost of heat at 0·73d. per kilowatt-hour compares with 1·25d. per kilowatt-hour under Plan 2, showing a reduction of 42 per cent. All the above figures are based on annual capital charges of 8½ per cent.

The foregoing unit costs, when compared with the cost of electricity under Plan 2, represent very considerable annual savings to consumers. The annual unit quantities, costs and savings are tabulated in Table IV.

The economies of Plan 3 come from the better use of fuel in industry and the conservation of heat now rejected in central power stations.

A further field for economy can be found in domestic and railway solid fuel consumptions. Here 45 million tons of coal are used each year, which would, if burnt in new heat-electric district heating stations, not only provide heat for the homes, but, additionally, electricity amounting to 14,000MW and 45,000 million kWh yearly. The tackling of this further economy might well constitute a second ten-year plan from 1965 to 1975 and would go a long way towards meeting the expanding demands for electricity, including the electrification of the railways.

Applying Research to Steel Works Plant and Operation

By R. F. JENNINGS, B.Sc.

Very large sums of money are spent on large-scale research for the development of industrial processes, but is this money used in the most effective way? And are our research efforts as a whole correctly balanced in relation to the needs of industry? The author suggests that not enough research effort is devoted to the design of steel-works plant as compared with that expended upon the development of processes, and he gives examples of items of plant, the design of which might be improved through the application of operational research.

TO-DAY there is a great volume of fundamental data in physics, chemistry, mathematics and the properties of materials at the disposal of the engineer and production man. Where machine design is the prime production problem as in aircraft manufacture, internal combustion engineering or bridge building, there is a direct channel for the application of such research data through the makers' design offices. The degree to which it is used, of course, may be a matter of opinion.

The F.B.I. report on Scientific and Industrial Research, published in 1947, however, showed that, in industries producing basic materials on a large scale, the ratio of research chemists to research engineers was almost 4½ to 1. Thus, a far greater weight is given to chemical research as compared with the investigation of engineering problems. Yet in works producing or servicing materials at the rate of 100,000 tons per year or more the potential value of plant development to-day often equals, or even exceeds, the possible improvement of the chemical processes by which the products are derived. The improvement of "productivity," of quantity production and in the increase in general industrial efficiency, which are considered the first essentials for this country's survival, are 90 per cent engineering problems. This is particularly true of a basic production process such as iron and steel making, in which the efficiency of the chemistry has reached a point where improvement is often obtainable only by major capital yielding a narrow profit margin. The main processes in the industry have been substantially stabilised for nearly a generation and the chemistry of transformation from the raw material to finished product is so known and calculable that the chemist can guarantee an efficient process. What he cannot ensure is that the engineering will match the process.

The major changes of the past twenty years in iron and steel making are in engineering. Increasing labour and raw materials costs have forced continuous increases in physical size, capacity, rating and output. Manufacturing arrangements are continually changing to increase the output of each plant and each employee, thereby reducing the cost per ton of the product. Incidentally, it is not necessarily true that the processes become more "efficient" with increasing size or throughput. There is a top limit to the value of physical size in this respect. In many processes increased output may mean decreased efficiency and yet lower overall cost of manufacture. As these changes continue and they have by no means reached their peak, the design and arrangement of plant become more and more complex, and the relationship of the demands of successive processes is increasingly important. At the same time the latitude in design is reduced as increased rating and output are required from each machine. Thus the need for improved specification of process equipment and methods of handling grows from year to year with the increase in cost and complexity of works. Unfortunately, in this respect there is often a big gap between the experience of the equipment manufacturer and the user. The manufacturer concentrates on detailed design with its many problems, while the user is concerned with production output and potential breakdown. Neither possesses all the data to specify the engineering duties of plant (as distinct from the process output). This gap in knowledge and experience can, however, be bridged by operational research of the right kind.

Problems of duty and output take many forms according to the process and equipment involved, but a few typical examples are: (*a*) it is impossible to specify the load on electrical motors in heavy duty cranes or other fluctuating machine drives, such as roller tables, by means of the conventional systems of rating. Thus a motor may be grossly overloaded in a particular application, leading to failure by overheating. The problem is not simply cured by the use of a larger motor, the dissipation of the increased inertia energy during rapid changes in speed may well present an equally serious thermal problem. Only a study of actual duties can help to determine the correct design of drive and particularly the best form of gearing.

(*b*) The specification of cranes and other high duty transporting machinery, such as hoists, tipplers, furnace chargers or grabs, can only be based on operational studies under particular duties. These duties usually involve motions of rapid acceleration and deceleration, which are rarely considered in conventional specifications. There are also instances where excess weight in construction to allow for supposed dynamic loadings has hindered the actual operation of the machine and prevented the desired rate of working from being obtained. Alternatively, lack of knowledge of duty stresses can lead to local structural failure; but the effect of impact and transient shock loadings cannot be properly countered by percentage factors added to the static loading. Such stresses must be measured when the machine is in actual working operation.

(*c*) The performance of rail traffic systems is governed by the material requirements, in the terms of gross tonnage and rate of delivery, of the various process departments in a works. It is all too frequent to find the locomotives and wagons idle for considerable periods while all the departments in a works claim there is a shortage of transport. To devise and organise an efficient system needs the closest observation of operating conditions and the application of statistical methods to the interpretation of the data.

(*d*) Crushers and grinders are notoriously unpredictable even on a theoretical basis and it is even more difficult to determine their performance with uneven loadings and a variety of materials. Again, operational studies alone can provide the clue to real performance.

(*e*) The specification and performance of furnaces, kilns or sinter plants particularly under unsteady heat transfer, are further cases where the actual variations of conditions from an assumed design value can determine whether the plant will operate satisfactorily. Only where the actual limits of conditions to be experienced have been measured in a works, e.g., the temperatures and heat distribution of steel ingots going to a soaking pit, can the requirements of a furnace be properly specified.

(*f*) Dust removal and gas cleaning plants are further examples where operating conditions are the principal limitation to plant performance. If high efficiency is required it cannot be predicted without study of the variations in the nature, size, concentration of dust to be removed. All too often plant is designed solely on a supposed condition of dust loading which may represent the mean conditions but not the variable loading with which the plant will have to deal from week to week.

When such factors remain unknown there is bound to be excessive caution in the specification of equipment and thereby waste of capital, or alternatively, possible failure through ignorance of the limiting duties required.

Operational studies are not easy to arrange when production has priority, but if these problems are not analysed at the right time it is often too late to influence the design and layout of new plant by last-minute experiments. There is, therefore, an urgent need for co-operative studies of these problems, while the plant is in full operation, and not only when it gives trouble or is about to be replaced. Production may be affected in some degree by such operational studies but limited interference should be far more acceptable, when planned and

agreed, than if it arises in the form of a breakdown caused by an unsatisfactory estimate of the duties demanded by the process. Simple data, such as pressure, temperature, flow volume and power consumption are frequently recorded and often controlled as a matter of course. It is therefore only an extension of the same principle to add, for short periods, a control of major variables to give more complete analyses of what actually happens in particular plant and how changes in such variables can affect performance. Surely this is not an unreasonable request in the light of the potential advantages to be obtained?

The essential aim of operational experiments, whether they be statistical analyses, time studies of machine operation, the measurement of transient response, observations on the behaviour of furnaces, &c., is that they should provide basically correct assessments of what the plant really has to do in a process and how it does it under limiting conditions. When this data is provided, even in the simplest form, the specification, design and arrangement of details cannot go far astray. This kind of research is, of course, already being undertaken by the larger companies in the industry and by the British Iron and Steel Research Association, but their efforts in this direction are still very small in relation to the yearly expenditure on new plant. The total operational and engineering research cost on iron and steel manufacture is probably below £200,000 a year whereas, in 1949, £42 million was being spent in new capital equipment in the iron and steel industry. New equipment for this industry is now costing about £50 million a year. If the throughput, or efficiency, of plant could be increased by 1 per cent it would be not unreasonable to suggest that a quarter of 1 per cent of the value of the annual net output (some £300,000,000) could be usefully spent upon operational and engineering research. This would mean an outlay of £¾ million for the steel industry, representing about 1½ per cent of the annual cost of new equipment.

It would seem that co-operative research organised through the Research Association can be particularly well expanded in this field, since it is closely linked with both producers and plant manufacturers. The Association's specialised research teams are well able to work with both production management and plant manufacturers, to overcome the many practical difficulties inherent in this kind of work. All that is needed to-day is the full appreciation of what might be achieved with real co-operative efforts.

Jubilee of Upper Boat Power Station

FIFTY years ago, on April 30, 1902, the foundation stone of Upper Boat power station was laid by Sir Frederick Bramwell, Bart, D.C.L., LL.D., F.R.S., the senior partner of Bramwell and Harris, of Westminster, the consultants to the South Wales Electric Power Distribution Company. This company was created in 1900 by one of the earlier electricity supply acts; Upper Boat was the principal power station to be built, and there were smaller ones at Cwmbran (near Pontypool, in Monmouthshire), Bridgend and Neath. The first of these smaller stations was shut down in 1909 after the Monmouthshire area had been connected to Upper Boat; the other two were handed over in 1908 to the Bridgend Rural District Council and the Neath Rural District Council respectively. The Bridgend station is still in operation with much of the original plant. In 1910, the Treforest Electrical Consumers' Company, Ltd., was formed to take over the operation of the power station and distribution system.

Public supply from Upper Boat power station was first given in April, 1904, when the original generating plant consisted of fourteen Niclausse boilers supplying steam at 200 lb per square inch to three Willans engines, coupled to Ganz alternators of 1500kW capacity each. The alternators were three-phase flywheel sets generating at 25 c/s; the exciter armatures were mounted on the main shaft with no exciter bearing. It is reputed that they were the first sets in this country to generate direct at 11kV, but in 1902 the maximum pressure for overhead lines had been specified as 500V! Apparently, no British maker was prepared to build machines of this voltage, so the order went to the Austrian firm of Messrs. Ganz at Budapest.

The Willans engines were unique; only four of this size were ever built, and three came to Upper Boat. As illustrated herewith they were three-crank, triple-expansion, central-valve engines of some 2500 h.p., and, they had a speed of only 150 r.p.m. The fourteen hand-fired Niclausse boilers evaporated 6000 lb of water per hour at 200 lb per square inch steam pressure; three of them were later converted to machine firing.

The reciprocating engines were run until 1908, when a British Westinghouse turbo-alternator of 3000kW output was installed; two Willans-Dick Kerr sets of 3000kW and 5000kW were added in 1911 and 1914 respectively. Two Babcock and Wilcox boilers were installed in 1917 and two Niclausse boilers in 1921, each evaporating 30,000 lb of water per hour at a pressure of 180 lb per square inch; the former were fired by chain grate stokers and the latter by Erith-Riley retort stokers. By 1938 all the above items of plant had been dismantled.

The steady growth of demand led in 1920 to an order for an 18,750kW turbo-alternator from C. A. Parsons and Co. for a steam pressure of 350 lb per square inch. Even before this set was commissioned in 1923, however, it was evident that more plant would be needed, and Mr. J. S. Highfield — later senior partner of the firm of Highfield and Roger Smith—was appointed as consulting engineer for further extensions. This necessitated the raising of additional capital, which was undertaken by the South Wales Electric Power Company, Ltd., formed in 1924.

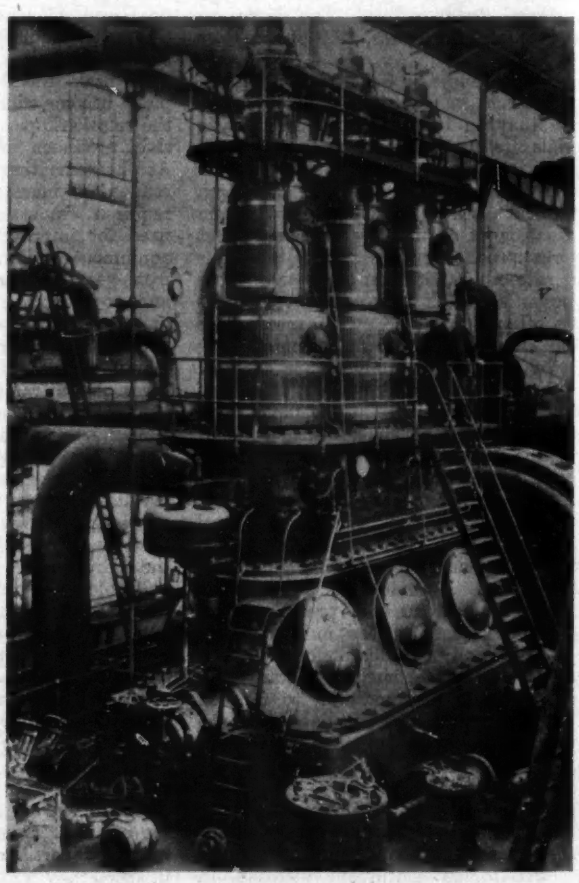
While the 18,750kW Parsons set was being built and installed in the old engine-room to meet the immediate increased demand, the company laid down a definite policy for future extensions. Steam pressure of 350 lb per square inch and a temperature of 750 deg. Fah. had already been settled for the first large turbo-alternator, and this was confirmed for future extensions. It was decided to enlarge the buildings to house eight boilers, each evaporating 60,000 lb of water per hour and two more 18,000kW turbo-alternators with necessary auxiliary plant. This extension was to be self-contained to enable the new plant gradually to replace the old.

When the new extensions were opened by the Rt. Hon. the Earl of Plymouth on April 26, 1927, there was, in addition to the Parsons set in the old part of the building, a 16,000kW English Electric turbo-alternator generating three-phase, 25 c/s alternating current at 11kV, with two auxiliary sets each of 1000kW output. In the new boiler-house there were eight Babcock and Wilcox "C.T.M." boilers of 60,000 lb per hour capacity producing steam at a pressure of 350 lb and a temperature of 750 deg. Fah. Each boiler was fitted with three chain grate stokers. In 1929, a 25,000kW Parsons set was installed.

In 1930, financial control of the South Wales Electric Power Company was taken over by the Shropshire, Worcestershire and Staffordshire Electric Power Company, a subsidiary of the Edmundson Corporation. When additional capital was raised in 1932, these holdings were again transferred by the Shropshire Company to the parent company, Edmundsons Electricity Corporation, Ltd.

A new problem had by now arisen—the changing of frequency from 25 c/s to the proposed standard rate of 50 c/s and with generating plant totalling 57,000kW this was no light task. The change-over was accomplished by 1937, however, and then the station was once more in the forefront of technical development in adopting a generating voltage of 33kV, an 18,750kW Parsons, 25 c/s machine being fitted with a 50 c/s alternator generating direct at 33kV. Later, it was decided to increase to 66kV for main transmission, and air blast switchgear was introduced. At the time of these last changes, the station superintendent was Mr. H. V. Pugh, who returned to South Wales in 1948 as Divisional Controller.

After the passing of the Electricity Supply



WILLANS ENGINE-DRIVEN ALTERNATOR

Act of 1926, Upper Boat became a selected station and was first connected to the grid in 1934, whereupon further extensions and alterations were made to bring the station to its present-day capacity of 155,000kW.

The station began using pulverised fuel in 1938, when a Babcock and Wilcox boiler, evaporating 182,000 lb of water per hour at a pressure of 650 lb and a temperature of 850 deg. Fah. was installed. Two similar boilers were added in 1939, and a further one in 1940.

The first 30MW set in this station was installed by the English Electric Company in 1939, generating direct at 33kV; a similar set was added in 1940. The great increases in generating capacity brought to a head the problem of cooling water. While, in the earlier days, the River Taff had provided adequate cooling supplies, in 1940 it was found necessary to erect a cooling tower with a capacity of 1,500,000 to 2,250,000 gallons per hour on what is essentially a river site station.

Another 30MW English Electric set was commissioned in 1942, generating at 11kV with a generator transformer stepping directly up to 66kV; two further boilers were installed—evaporating 364,000 lb of water per hour and 182,000 lb per hour respectively; both boilers have a pressure of 650 lb per square inch and a temperature of 850 deg. Fah.

The present station, therefore, is composed of two systems—the high-pressure and low-pressure sections, and they are connected by two reducing valves so that steam can be supplied from the h.p. boiler-house to the l.p. sets. Five of the six boilers in the h.p. section use pulverised fuel. Details of existing plant are tabulated herewith:

Turbo-Alternators

Set No.	Capacity, MW	Steam pressure, lb per sq in	Steam temperature, deg. Fah.
4, 5, 6	30	625	825
7	18	325	725
8	20	325	725
9	25	325	725

Boilers

Boiler No.	Pressure, lb per sq in	Temperature, deg. Fah.	Capacity, lb per hour
1, 2, 3, 4, 5, 6, 7, 8	350	750	60,000
8a	650	850	364,000
9, 10, 11, 12, 13	650	850	182,000

Most of the energy generated is transmitted for local distribution at 66kV, 33kV and 11kV, the approximate local area of distribution extending to Margam (Port Talbot) in the west, Panteg and Pontypool in the east, and Hirwaun (Aberdare) and Dowlais (Merthyr) in the north. At the same time, electricity is exported to and imported from the national grid. Apart from the electricity supply from this station, the Wales and Monmouthshire Industrial Estates, Ltd., take, a steam supply at 350 lb per square inch pressure.

Recently Upper Boat has been undertaking special tests on chimney grit emission from large boiler plant. A comprehensive programme of testing for grit emission and collector efficiency, using sampling apparatus of recent development, has been under way for the past eighteen months. The result of this work has enabled design modifications to be made to improve the efficiency of the grit-collecting plan and a satisfactory pulverised fuel sampling apparatus has been developed in collaboration with the Fuel Research Station, which will enable an accurate measurement of the performance of the pulverising mills to be made with comparative ease.

Shortly after April 1, 1948, when the station was vested in the British Electricity Authority, Mr. W. J. F. Debley was appointed station superintendent, and to-day the station employs about 400 people.

Synthetic Resins for Foundry Use

An account is given of the properties of cores bonded with synthetic resins and their use in other moulding processes. The materials and techniques described are those now under investigation and development at Imperial Chemical Industries, Ltd., Plastics Division, Welwyn.

IT was known some years before the last war that Germany had begun to use synthetic resins as the bonding agent in sand cores and had later, towards the end of that war, advanced their use in a process known as the "Croning" process, and now known here as the "shell" moulding process. This was a technique for mass-producing castings of a limited size and character with precision and depended solely on the hardening properties of a resin-bonded sand formed around a heated metal pattern, the mould shell or half-shells thus formed being supported usually by steel shot during the pouring process.

A shortage of linseed oil during the war led this country in 1942 to investigate the properties of resin-bonded cores and their use to-day has been notably extended by their adoption in a number of larger mechanised non-ferrous foundries and ironfoundries in this country. The significance of the "shell" moulding process, however, was not so quickly realised, and the first paper dealing with this technique and largely based on the German principle was not published until 1947, and then by the Department of Commerce in America.

In both these applications of synthetic resins to moulding practice, the Plastics Division of the Imperial Chemical Industries, Ltd., has made some important contributions, and we were able to view some of the work during a visit last week to the laboratories of its technical service and development department at Welwyn Garden City.

Resin-Bonded Cores

There are two resins currently being manufactured for core bonding, one being constituted with ural and formaldehyde (U.F.), the other being a phenol-formaldehyde resin.

At the present time U.F. resin binders can be marketed for £70–£80 per ton, which is comparatively low in cost compared with the majority of binders available, particularly those using linseed oil which was stated to cost about £200 per ton. The green strength of these cores is probably their disadvantage, but satisfactory cores can be made with relatively low quantities of resin binder. Such cores can be dried in a shorter time than oil-bound cores. This time varies with the size of core, the differential increasing with core size until, with cores of over 100 lb in weight a U.F. resin-bound core may be oven baked in under two hours against ten hours or more for many types of oil-bound cores. Using dielectric heating, U.F. resin-bound cores may be dried in a few minutes.

The breakdown temperature for U.F. resins is 220 deg. to 270 deg. Cent. against 450 deg. to 500 deg. Cent. for linseed oil. Consequently, for non-ferrous casting, where comparatively low casting temperatures are used, U.F. resin-bound cores show rapid and complete breakdown with subsequent freedom from faults in castings due to insufficient core collapse.

Another advantage revealed by production experience indicates subsidiary qualities of U.F. resin-bound cores such as freedom from finning on castings and quality of castings produced.

The P.F. resins have only one marked characteristic different from the U.F. resins, i.e., breakdown temperature, which in the case of P.F. resins is 400 deg. to 450 deg. Cent., little lower than that of linseed oil. The important property of breakdown temperature makes P.F. resin-bound cores suitable for all types of ferrous casting. Of particular interest is the fact that low gas evolution of P.F. resin-bound cores during burning out is a definite contribution towards freeing the foundry from objectionable fumes during casting. P.F. resin-bound cores can be baked at similar temperatures to those used for drying oil-bound cores and it is possible to run P.F. and oil-bound cores simultaneously through the same oven.

The foundry trade in this country is mainly based on ferrous casting, largely ironfounding. It is expected that of the synthetic resins developed for core binding, the P.F. resins will ultimately achieve the greatest significance because of their value in this type of work. The increasing interest in this type of resin throughout the foundry trade at the present time substantiates this view.

R.F. Drying of Resin-Bound Sand Cores

The use of dielectric heating makes possible the drying of resin-bound sand cores within a few minutes, a substantial time saving over conventional oven-drying methods. Special U.F. and P.F. resins have been developed suitable for use as core binders where dielectric heating is applied, and already this drying technique is in use in several foundries in this country. It is especially suited to mass production foundries on repetition production.

A particular problem met with dielectric drying of cores has been overcome by the introduction of polyester resin, for the manufacture of core carriers or dryers. The function of the core carrier is to support the sand core during drying. Essential properties of such core carriers include suitable electrical properties to prevent energy loss, dimensional stability, robustness and ease of manufacture. A glass cloth reinforcement is generally used.

The properties of a number of different simple cores were demonstrated during our visit. These cores mostly contained to 100 parts of sand, 2 parts resin, 1 to 2 parts starch binder, 2 to 3 parts water, and a trace of Bentonite, and constituted a generally representative mix. In certain cases as low as 3/4 part of resin will suffice, however. It was noted that a resin content, whilst otherwise sufficient for the dry strength of the core, was not sufficient except in certain cases to retain the form of the core without its sagging or disintegration. The company, however, has developed a number of its "Mouldrite" resins, which, within the proportion stated above, provides a sufficient "wet" strength, although somewhat less than that shown by the standard tests upon conventional core mixes. When dried the cores demonstrated broke down at about 600 lb to 800 lb per square inch. Much higher resin contents, however, are needed where a core has substantially overhanging parts such as collars, &c., and dry strengths up to 1600 lb per square inch have been obtained. Beyond these resin requirements the process becomes uneconomic. The heaviest cores so far produced weigh in the region of 3 tons.

Surface Hardening of Sand Moulds

Sand moulds, as opposed to sand cores, are substantially "green" sand, i.e., the sand contains little or no binder. Such sand moulds have over a long period of time been found satisfactory for most kinds of castings, but on certain moulds there is a tendency for the surface of the "green" sand to be washed away by the flow of molten metal.

A technique for the surface hardening of sand moulds, based on accelerated U.F. resins, is proving an economic method of overcoming this problem. It is possible to spray the mould with a mixture of U.F. resin and accelerator which will harden within an hour at normal temperatures, or within minutes under heat giving a surface-hardened "green" sand mould having greatly improved resistance to washing and pitting by molten metal during casting. On the same basis it is considered that many types of core should be capable of being made with a "green" interior inside a case-hardened skin; such a core would offer appreciable

advantages over present techniques of core making in reduced fuming, improved breakdown and economy of binder consumption.

The Sand Shell Moulding Process

The sand shell moulding process is essentially a method by which thin shell sand moulds suitable for use as casting moulds may be rapidly produced. The process involves the use of a dry sand/resin mixture, the resin being a powder P.F. resin, this dry mix being allowed to fall on to a heated metal pattern surface where it softens to form a thin shell adhering to the pattern. The pattern and shell are then transferred to an oven where, within a few minutes, the sand shell hardens and may be lifted from the pattern. The cycle is then repeated. Total cycle time for the making of the finished shell mould is three to five minutes, and the pattern is maintained at constant temperature.

The method lends itself to high precision casting, and it was stated that finishes up to $^{1}/_{1000}$in are obtainable. The sand shell reproduces fine definition from the pattern surface, and when used as a casting surface imparts the same definition to the casting. Thin metal sections are readily cast. The type of resin developed for this application is a P.F. powder resin, of fine mesh, capable of softening rapidly and then hardening within a few minutes at the pattern temperature, i.e., approximately 450 deg. to 500 deg. Fah. The quantity of resin used in the sand mixture is normally 6 to 8 per cent.

The porosity of this sand mould is one of its most important characteristics and is, of course, the main factor in the high surface finish obtained. During a demonstration cigarette smoke was easily blown through a piece of a mould $\frac{1}{8}$in thick, and during "pouring" in some moulds the actual progress of the metal through the mould is revealed by the gases as they escape through the pores. The strength of these shells depends upon their thickness, and in many cases the metal can be poured whilst the two halves are simply pinned or clamped together. In other cases, they can be backed by steel shot. With most economical mixes, due to the rapid break down of the resin at the metal temperature, the technique is restricted to castings of limited size, but many of the parts for which it is admirably suited such as small and large-finned cylinders, form components of mass-produced articles.

Many branches of the engineering industry are now showing a marked interest in this process, and it is believed that it will achieve a widespread application in a few years.

Cement Research.—New research laboratories at the Greenhithe, Kent, works of Associated Portland Cement Manufacturers, Ltd., were opened on Friday, July 11th, by the Minister of Works, Mr. David Eccles.

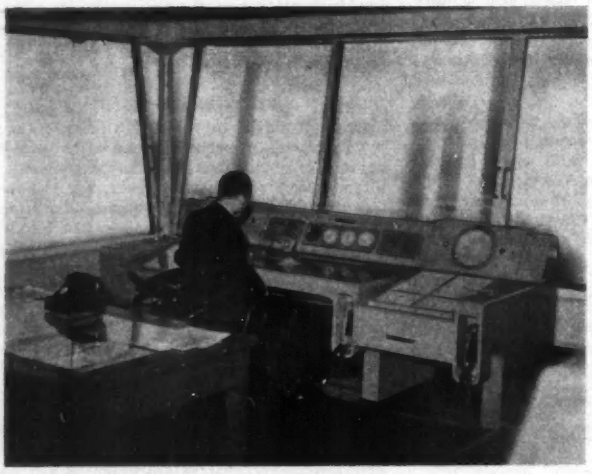
Navigational Aids at Dunsfold Airfield

Dunsfold airfield, near Guildford, which was recently taken over by the Hawker Aircraft Company, Ltd., now possesses a new control tower equipped with modern radio and navigational aid equipment, including two v.h.f. D/F installations. The facilities provided for the controller are three v.h.f. channels for communication with aircraft, with automatic D/F on two of them, one v.h.f. channel for contact with the fire appliance, and telephonic communication with selected people on the airfield, together with other necessary authorities, in addition to the normal airfield exchange. Provision has been made for a further v.h.f. channel to be fitted at a later date.

The installation is centred on an air traffic control desk which has been especially designed by International Aeradio, Ltd., to fulfil the requirements of the controller. The accompanying photographs show the general layout and it will be seen that everything which the controller is likely to require in the course of his duties is immediately available. From the panel in front of him he can determine the local meteorological conditions as a barometer, wind speed and wind direction indicators, together with a clock, are fitted in the control escutcheon. The heads for driving the wind speed and wind direction indicators are mounted on the roof of the tower. The two escutcheons, on either side of the meteorological one, house loudspeakers to which the receivers on the radio channels are connected. To identify the channels, close to his left hand, the controller has four luminous indicators, on the caps of which are engraved the frequencies. During reception, a lamp inside the indicator is illuminated, showing which channel is calling, whilst to transmit, the controller merely depresses the indicator and speaks into the microphone. A fifth indicator gives broadcast facilities, which can be used in the event of an emergency. It will be noticed that no volume controls are available on the desk; they are unnecessary as a special amplifier is fitted between the receiver and loudspeaker which gives a constant output irrespective of the input. The output is set to the required level during installation, and thereafter it is not touched. For the radio side of his work, therefore, the controller has the minimum number of controls; indeed, the business of talking to aircraft is made nearly as easy as a telephone conversation. To cater for the occasion when two aircraft might call at the same time on different frequencies, a further facility has been fitted to the luminous indicators whereby lightly depressing any one cuts out reception on that channel, thus permitting the controller to talk uninterruptedly on the other one.

To give the controller instant telephone communication with selected extensions, there is, in front of the radio control panel, another panel which, in conjunction with one of the vertically-mounted telephone handsets, gives him direct connection to the fire station, briefing room and any other people with whom instant communication may be necessary. Another telephone is connected to the aerodrome exchange for ordinary calls.

Underneath a glass panel directly in front of the controller there is a map showing 70 miles radius from the aerodrome, which is used for homings and controlled descents. To his left, on the sloping portion of the navigational section of the desk, there is a map upon which he can plot the D/F bearing of an aircraft and, with the aid of other D/F stations at Hatfield and Chilbolton, fix its position. On the sloping portion of the other navigational section, there is an aircraft movements board, on which is kept a check of all aircraft under the control of Dunsfold. A panel let into the far left-hand side of the desk controls all the airfield and traffic control lights.



Air Traffic Control Desk at Dunsfold

V.H.F. Direction Finder Consoles at Dunsfold

The two circular meters in the two navigational sections are part of the Marconi automatic v.h.f. D/F equipment (type "AD200") which is a twin-channel D/F system capable of presenting simultaneously two sensed bearings on two different frequencies. The aerial assembly is mounted on a pivoted tubular mast; the console housing the two receivers, modulators and oscillators which provide the signals feeding the remote consoles, is installed in a small building on the airfield, and two pairs of ordinary telephone lines run from there to the tower. Two remote consoles are installed in the control tower, as shown in our second illustration; they contain the remote control circuits, demodulators and phase comparison units, which provide the voltages to operate the meters on the desks. By operation of a switch on the console it is possible for the presented bearing to be either "QDM" or "QDR," the selection being indicated by illumination of a lamp by the side of the motor. Although in this installation the aerial system is a matter of a few yards from the tower, it is possible for it to be up to 30 miles distant.

The radio equipment for air/ground communications is installed in two 6ft fully enclosed rack cabinets, which have doors at the front and panels at the rear which can be locked to prevent unauthorised entry. Both the v.h.f. transmitters and receivers are crystal-controlled; the former have an output of 10W to 15W over the civil aviation band, whilst the latter are double superheterodyne receivers, having a sensitivity of less than 1μV, and incorporating

a carrier-operated muting circuit, which is noise compensated. The constant volume amplifiers referred to above, together with microphone amplifiers, which incorporate relays for switching on the transmitters and other functions, power units for operation of these relays and indicator lamps, &c., complete the equipment contained in the two cabinets.

The survey, planning, supply and installation of the radio communication equipment and the air traffic control desk was undertaken by International Aeradio, Ltd. Installation of the "AD.200" D/F equipment was carried out by Marconi's Wireless Telegraph Company, Ltd., the manufacturers of the equipment.

Transformers for the Swedish 380kV Network

A full description of the Swedish 380kV transmission line connecting Harspranget, Midskog and Hallsberg was given in papers presented at C.I.G.R.E. meetings Paris, in 1948 and 1950. The design of the transformers was, however, only mentioned briefly. In the 1952 paper, from which the following abstracts are taken, the author, Emil Stenkrist gives some details of the transformers.

During the preliminary stages of the design it became apparent that only transformer units of very large size would be economically feasible, and this gave rise to the necessity for specially constructed transport wagons both for road and rail. On the railways a wagon with twelve axles with 20 tons load per axle was permissible; this gave a total load of 240 tons, and a net maximum weight of 180 tons. It was therefore stipulated that the total weight of the complete transformer in its tank, excluding oil, cooling system and high-voltage bushings, should not exceed this figure; this meant that the transformers could be sent in their own tanks and so avoid the necessity of repeating the drying out process at the place of installation. Having regard to the railway free loading gauge, a maximum height of 4800mm above the top of the rail was permitted. The transformers had furthermore to be able to carry safely the short-circuit power of the 380kV system, which may

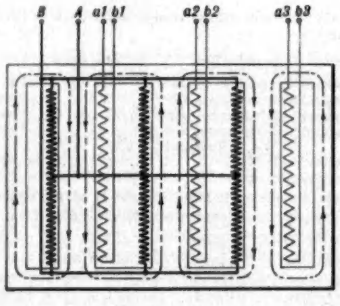


FIG. 1—*The General Arrangement of the Single-Phase, 115MVA Transformers for Harspranget*

amount finally to approximately 8000MVA for the different stations. Regulation of the high-voltage side over a range of ±15 per cent was also necessary to cope with the different operating conditions. Finally, since the 380kV system is intended for direct earthing, the 380kV windings could be made with graded insulation, while the 220kV windings had to be made fully insulated at that time.

Step-Up Transformers at Harspranget

The station is equipped with three generators, each of 105MVA nominal rating. The transformers have been dimensioned with regard to the fact that the station can give a constant output of 315MVA at voltages varying between 400kV and 350kV on the high-voltage side assuming a constant generator voltage. The regulation is achieved by means of a separate regulating set, which is connected between the neutral ends of the high-voltage windings and earth, and which is capable of either plus or minus regulation. The station is also equipped with a total of 3×40MVA reactors. Having regard to the voltage drop in the main and regulating transformers with full-load current in the regulating units, the nominal rating of the main transformers has to be somewhat greater than the rating of the generators and actually reaches 345MVA.

The question of how this power should be divided between units of suitable size has been closely examined. For the main transformers there existed the following alternatives:—

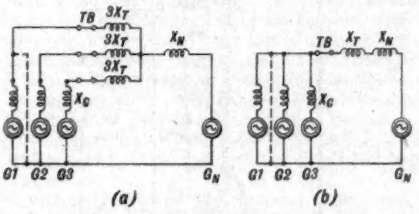
(*a*) 9×1-phase units of 38·3MVA=3-phase groups of 115MVA.

(*b*) 3×3-phase units of 115MVA=3-phase groups of 115MVA.

(*c*) 6×1-phase units of 57·5MVA=3-phase groups of 172·5MVA.

(*d*) 3×1-phase units of 115MVA=3-phase groups of 345MVA.

Alternative (*a*) gives simple and easily handled units, but had to be turned down on account of the high cost. Alternative (*b*) was considered to be out of the question for the first 380kV delivery, owing, among other things, to the difficulty of obtaining sufficient clearance



(*a*) Arrangement with split-winding transformers.
(*b*) Arrangement with standard two-winding transformers.

FIG. 2—*Impedance Diagram for the Network and Generating Station at Harspranget*

between the 380kV bushings. Alternative (*c*) presupposes busbars on the primary side, which leads to excessive short-circuit currents and power. Alternative (*d*) gives the lowest cost, but the disadvantages of alternative (*c*) are even more in evidence, as the line current at 345MVA and 16kV is 12,500A. Circuit breakers for the equivalent short-circuit currents and breaking capacities do not appear to be manufactured nowadays. Fig. 1 shows the arrangement adopted. As can be seen, the transformers have the high-voltage windings on the three legs connected in parallel, and have the primary winding split into three parts, one per leg, each of them with a separate bushing. To these are connected the relevant phases of the three generators. As far as construction is concerned, the transformer is exactly like a normal three-phase transformer with five legs, except that it is provided with one high-voltage bushing instead of three.

In order to calculate the behaviour under short circuit, the network may be represented as in Fig. 2(*a*), where X_T is the short circuit reactance per leg for the transformers, and where X_N and G_N represent the network connected to the high-voltage side.

With the conventional connection of the transformers the network is changed to Fig 2(*b*) A short circuit on the generator busbars is shown in the figures by the dotted lines. The short circuit duty on the transformer circuit breakers (*TB*) is reduced in the proportion $\frac{X_N+X_T}{X_N+3X_T}$; with $X_N=4$ per cent, and $X_T=10$ per cent, the short-circuit power is reduced to 41 per cent, while the rated current is reduced from 12,500A to 4200A.

The Midskog Transformers

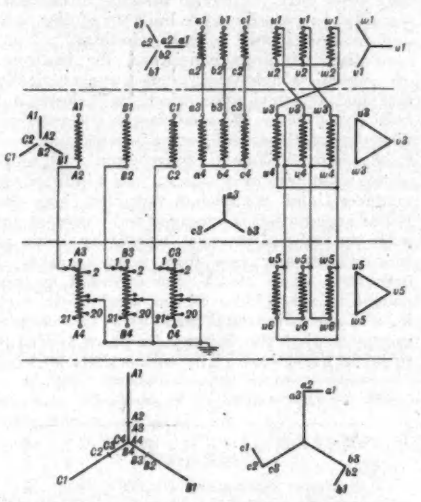
In this station, situated at the middle of the 380kV line, the power from the 220kV block at Indalsälven is connected in by a transformer group rated 330MVA–408/258kV, which is also provided with a tertiary winding of 225MVA–36·5kV. This tertiary winding is used to feed the separate regulating transformer, which regulates the 380kV voltage and is connected between the high-voltage windings and earth; it also feeds the phase-shifting transformer connected to the 220kV lines, which controls the power distribution between the parallel-connected 380kV and 220kV lines; and finally, it is used for the connection of 180MVAr of reactive power split up into three-phase units of 60MVAr each. The determination of the load for which the transformers were to be dimensioned was awkward due to the several different possible operating conditions, with various load voltages, and hence different loadings of the tertiary winding feeding the regulating units. It was found that the regulation necessary on the 380kV side was ±15 per cent. The transformers for phase-angle control constitute a three-phase group of 50MVA. The secondary windings are connected in series with the 220kV line and give an additional voltage of $j58/\sqrt{3}$kV, which can be reconnected to give $j29/\sqrt{3}$kV. Fig. 3 shows the connection of the main and regulating transformers in this station. As the voltage on the secondary winding could be chosen arbitrarily, the relatively high value of 36·5kV was chosen in order to get a reasonable value for the phase current (2050A). The short-circuit powers are certainly large, but not so large as to necessitate the use of split windings. As there are no other reasons for further subdivision of the windings these transformers have been made with only two legs carrying windings. The equivalent two-winding rating per transformer is thus

$$\frac{1}{2}(110+110+75)=\text{about } 150\text{MVA},$$

or 75MVA per leg, which is approximately 50 per cent more than that of the sizes previously built by any firm. To reduce its height, the core has been made with two unwound outer legs similar to the Harspranget transformers. The 220kV windings of these transformers are designed according to the insulation level 1025kV, without grading to earth.

Hallsberg Step-Down Transformers

During the first stage of construction of the Swedish 380kV system, the power was transmitted to the receiving station at Hallsberg,



a_1, b_1, c_1; u_1, v_1, w_1, phase-shifting transformers.
A_1, B_1, C_1; a_2, b_2, c_2; u_2, v_2, w_2, main transformers.
A_2, B_2, C_2; u_5, v_5, w_5, regulating transformers.

FIG. 3—*Connection Diagram for the Main and Regulating Transformer Banks at Midskog*

where it was transformed and fed into the existing 220kV network. In the early stages the transformers were to be supplied with separate windings, since direct earthing of the 220kV system was not acceptable owing to the risk of interference with the telecommunication network. This question was in the meantime closely examined and it was found that direct earthing may be permissible at least for certain stations. Thus, the question arose of adopting auto-transformers for stepping down.

Owing to the fact that the voltage ratio is so favourable in this case, the advantages of auto-transformers are obvious, since not only is the transformer core appreciably smaller, but also the lower reactance of an auto-transformer is an economically decisive factor.

For the final arrangement auto-transformers were therefore chosen and the station has been

equipped with two three-phase banks of $300/300/150\text{MVA} - \frac{400}{\sqrt{3}}/\frac{225}{\sqrt{3}}/21{\cdot}5\text{kV}$.

The tertiary winding is used to feed a separate regulating unit, connected to the 220kV side, which is used to regulate the voltage within ±9 per cent. This tertiary winding is also connected to a synchronous condenser of 75MVA and to a reactor bank of 120MVAr divided into two units of 60MVA each. The advantages of the auto-transformer connection can be seen from the comparison in the following table, which gives the relationship between auto-transformers and double-wound transformers:—

	Relative value
Short-circuit voltage for 400/225kV, 300MVA...	0·45
Short-circuit voltage for 400/21·5kV, 150MVA	1·00
Short-circuit voltage for 225/21·5kV, 150MVA	2·00
No load losses	0·63
Copper losses...	0·64
Weight, excluding oil	0·68
Weight of oil	0·62

As far as design is concerned the transformers are, in fact, almost exactly the same as the Midskog transformers, except that, owing to the auto-transformer connection, they could be made with only one wound leg.

Design of the Transformers

The extension to 380kV of the voltage for high-power transmission means that the limit of existing operating experience will be considerably exceeded. In addition, it should be noted that the power has been concentrated in units of a size hitherto unused. Both these factors lead to a certain amount of conservatism and cautiousness regarding the design to be adopted. A leading principle has therefore been to use well-tried methods and to keep the design as simple as possible. Because of the manufacturer's* experience with core type transformers for high voltages, it was decided to consider that type only. For the sake of mechanical stability, the windings are built up of disc coils and conventional helical windings. Non-oscillating windings consisting, for instance, of several single-layer coils concentrically arranged ("multi-layer windings") have not been chosen since the manufacturer is not convinced that these can be made with sufficient strength to withstand short circuit in units of the sizes here in question. All windings are made without regulating tappings, and the voltage regulation is arranged to be carried out with the help of separate regulating units, as required, in any case from considerations of transport. The 380kV line terminal is connected to the middle of the winding on each leg and each winding is made up of two parallel groups so that the voltage decreases gradually towards the yokes. The connections between winding and bushing often give rise to extra trouble, and in this case they have been entirely excluded by means of the arrangement shown in Fig. 4. As can be seen, the bushing, which is a normal solid condenser bushing, has been made with the lower part prolonged beyond what is necessary, so that the high voltage is brought directly to the middle of the leg. The condenser core at the lower part of the bushing is fitted inside a separate containing porcelain which itself is clamped tight to the underneath side of the tank cover. At its lower end the porcelain is fitted with a metal sphere of large diameter, which is insulated with paper in order to keep the insulation clearances from the tank within reasonable values. As the containing porcelain is hermetically sealed against the oil in the transformer, the bushing may be inserted or removed without lowering the oil level or opening up the transformer, which is especially advantageous at transports and erection on site.

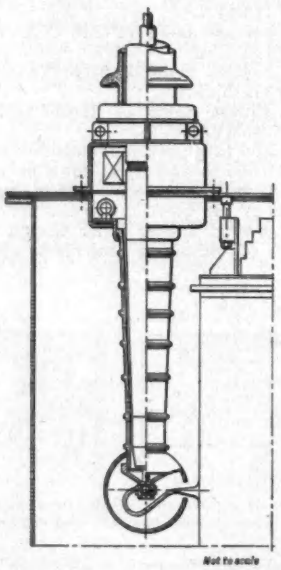


Fig. 4—*Arrangement of the Lower Part of the 380kV Bushing and the Connection to the 380kV Winding*

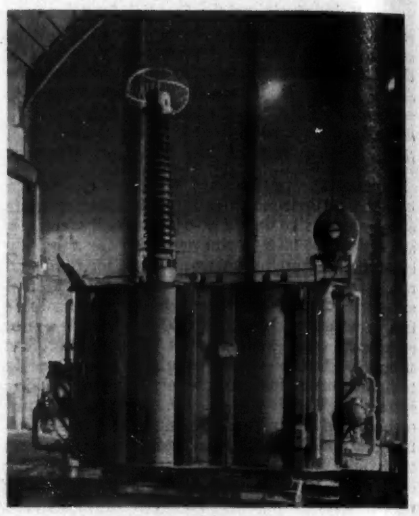
The question of the ability of the windings to withstand surges was, of course, very closely examined. Several different screening methods were investigated in order to diminish the voltage oscillations, both with respect to earth and between adjacent coils. The problem is to get the capacitances between the screens and windings proportioned correctly.

The final arrangement consists of some simple electrostatic screening rings placed in suitable positions between the line end coils and connected to the line terminal. The voltage across these coils amounts to 10 to 20 per cent of the amplitude of the test surge with 1/50 wave form. The insulation between the coils has been carried out by using large coil distances and by protecting the coils with one or more insulating collars. The main insulation to earth was dimensioned very liberally, which is proved by the fact that no radial breakdown occurred in this insulation during test; in all cases the bushing flashed over first.

The desired low reactance of the winding could, of course, be obtained by the help of a double concentric arrangement, but it was achieved by a combination of large core diameter and leg length giving a small number of ampere turns per centimetre of winding length.

Some particulars of the transformers are given in the accompanying table. The transformers for Harspranget and Midskog are illustrated in Figs. 5 and 6 respectively.

The 380kV bushings were designed as normal condenser bushings with protecting porcelains on both the upper and lower end, the latter one, as previously mentioned, being clamped to the tank cover. During service the space between the condenser core and the protecting porcelains is filled with oil on both sides, and the two oil chambers communicate with one another. During transport and storage the lower part is enclosed in an oil-filled sheet metal tank. The condenser core is solid without channels and, for mechanical reasons, is made of bakelised paper with a minimum amount of resin in order to hasten drying and facilitate impregnating with oil. In spite of this being done under the highest possible vacuum, the dielectric stresses have been kept very low, necessitating a large outside diameter for the paper core. Neglecting the cores for the current transformers, the weight of the bushing is 2500kg.



$115\text{MVA} - 16/\frac{370}{\sqrt{3}}\text{kV}$.

Fig. 5—*Transformer for Harspranget*

Impulse Test with 1/50 μs wave

Withstand test (dry) pos. polarity	>1950kV
Withstand test (dry) neg. polarity	>2100kV
Withstand test (wet) pos. polarity	1850kV
Withstand test (wet) neg. polarity	>1900kV
Test with 50 c/s	
Withstand test (dry)	> 900kV
Withstand test (wet)	> 781kV

The top cap is designed as a large diameter cage made of 10mm galvanised iron rod. On tests with successively increasing voltage the first signs of corona are to be seen on the top cap at approximately 350kV to earth. The corona round this extends about 450mm at a voltage of 700kV, but up to this voltage it is completely steady. If the voltage is increased above this the corona develops discharge streamers which at 900kV extend approximately 3m out from the bushing.

The dielectric losses in the condenser core have been measured with the lower part immersed in oil at different temperatures, giving a tan δ at 400kV to earth and 90 deg. Cent. of

Particulars of Transformers for Swedish 380kV System

	Harspranget		Midskog			Hallsberg	
	Main transformers	Regulating transformers	Main transformers	Regulating transformers	Phase-shifting transformers	Main transformers	Regulating transformers
Rated capacity, MVA...	3×115	3×9·3	3×110/110/75	3×15	3×16·7—8·35	3×100/100/50	3×9
Rated voltage, kV	$16/370/\sqrt{3}$	$16/\pm 30/\sqrt{3}$	$\frac{408}{\sqrt{3}}/\frac{258}{\sqrt{3}}/36{\cdot}5$	$32/\pm\frac{55}{\sqrt{3}}$	$\frac{32}{\sqrt{3}}/\frac{58}{\sqrt{3}}-\frac{29}{\sqrt{3}}$	$\frac{400}{\sqrt{3}}/\frac{225}{\sqrt{3}}/21{\cdot}5$	$21{\cdot}5/\pm\frac{20}{\sqrt{3}}$
No load losses, kW	272	26·6	358	37·0	59	211	40
No load current, per cent	2·1	2·4	4·0	2·3	3·4	2·1	4·1
Load losses, kW	468	64	—	87·2	78·5	—	67·0
Impedance, per cent	10·8	7·2	—	7·5	8·9	—	13
Weight, excluding oil, tons...	151	19·3	184	30	38	126	36
Weight of oil, tons	37	7·9	47	14·4	16·5	33	19
Insulation level, kV	125/1775–275	125/275	1775–375/1025/175	175/375	175/1025	1775–375/1025/125	125/1025

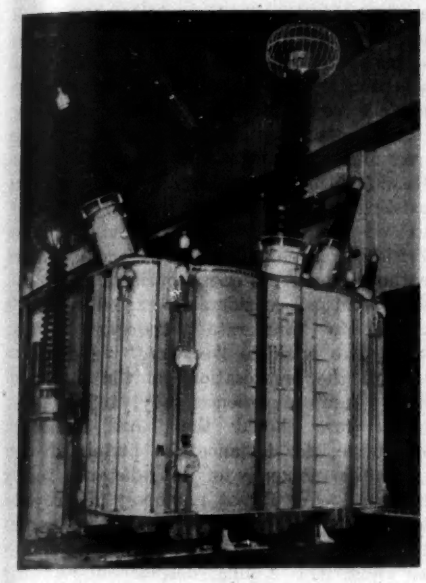
All the transformers are forced oil-cooled, single-phase, with the exception of the regulating transformers at Hallsberg, which are three-phase units.

* A.S.E.A., Ludvika, Sweden.

approximately 0·007. The bushing has been tested at 400kV for 48 hours in oil at 90 deg. Cent., after which time the losses were found to be unchanged. The first prototype has been used for type tests and the acceptance test on the transformer, and has, up to the present, been subjected to about 200 surges with amplitudes between 1200–2100kV without any damage.

The Regulating Transformers

For reasons already explained, the voltage regulation is obtained by means of separate regulating units, fed from the primary (Harspranget) or tertiary (Midskog and Hallsberg) windings on the main transformers. These regulating transformers are of considerable size and, therefore, arrangements were made



$110/110/75\text{MVA} - \frac{408}{\sqrt{3}} \Big/ \frac{258}{\sqrt{3}} \Big/ 36 \cdot 5\text{kV}.$

Fig. 6—*Transformer for Midskog*

to reduce the rating as far as was possible. For this reason the use of transformers with exciting and series windings has been avoided, in spite of the fact that the tap changers in this case could have been put in a separate intermediate circuit with suitable values of current and voltage. The regulating transformers have instead been connected directly on the 380kV side between the main transformers and earth. By using ± regulation the size has been reduced by one-half, but remains nevertheless relatively large (three-phase groups of 45MVA at Midskog). With this arrangement the question of the insulation level has to be especially considered as the main transformer is not directly earthed, but only through the windings of the regulating transformers. The incoming voltage wave is divided in a proportion quite different to that obtaining under 50-cycle conditions. The voltage in question is highly dependent on the connections of the low-tension windings. If these are in parallel, which is the case in normal service, the voltage to earth at the connection between the too high voltage windings, for the most unfavourable position of the tap changer, becomes 27 per cent of a 1/50 wave applied to the 380kV terminal, and 30 per cent if the wave form is 1/250. The voltage at this point is sinusoidal with a frequency of about 25,000 c/s. This means that the lower part of the high-voltage winding of the main transformer and also the regulating transformer would require an insulation level of 525kV. It is, however, fairly easy to protect this point with lightning arresters, as both the steepness of the sinusoidal wave and the current amplitudes are very low in relation to the values existing for an arrester connected between the line terminals and earth. The insulation levels have been chosen at 375kV for Midskog (±15 per cent regulating unit) and at 275kV for Harspranget (±9 per cent regulating unit), which is considerably more than what is really needed.

The regulating transformers are provided with complete protection by lightning arresters, both between the regulating winding and earth and on the primary side also, in order to protect them against transferred over-voltages.

The Transport Bill

The text of the Transport Bill was published last week, after the Bill had been introduced in the House of Commons on July 8th. We print below extracts from the explanatory memorandum of the Bill, setting out the main provisions:—

The main purpose of the Bill is to provide for the disposal of the British Transport Commission's road haulage property, to provide for a levy on certain goods vehicles and tractors used on roads and to provide for the reorganisation of the British Railways. The Bill also provides for the modification of the powers, duties and composition of the British Transport Commission, including powers in relation to charges.

The British Transport Commission is required to dispose as quickly as is reasonably practicable of the property held by the Commission for the purposes of that part of its undertaking which is carried on through the Road Haulage Executive.

The provisions of the Transport Act, 1947, relating to compulsory acquisition by the Commission of road haulage undertakings are repealed, but the Commission's power to provide road haulage services and facilities remains.

The Commission is required to invite tenders for the purchase of the road haulage property divided into units referred to as "transport units." The purchaser will be entitled to a special carriers' "A" licence for all vehicles in units (other than vehicles specifically excepted from this right). A Board is to be set up (known as the Road Haulage Disposal Board) with certain duties in connection with the disposal of the units.

The Commission may set up companies to engage in road haulage, and with the consent of the Minister of Transport transport units may be made over to them up to a limited amount.

With the Minister's consent road haulage property may be disposed of otherwise than in transport units or retained by the Commission for its other activities.

Section 59 of the Transport Act, 1947, which exempts the Commission from the obligation to have carriers' licences under the Road and Rail Traffic Act, 1933, is repealed, and the Commission is to be entitled to the issue of the appropriate carriers' licences in respect of its vehicles at the passing of the Act.

Section 52 and other provisions of the Transport Act, 1947, relating to the 25-mile restriction on road haulage are repealed as from an appointed day.

The Bill provides for certain changes in the statutory provisions governing the licensing system for goods vehicles, the main changes being modifications of Section 11 (2) and Section 13 of the Road and Rail Traffic Act, 1933.

A levy will be payable on certain classes of goods vehicles and tractors and the money collected is to be paid into a Transport Fund controlled and managed by the Minister. A contribution to the Fund will be payable in respect of vehicles used for the purposes of Government Departments, other than the Service Departments.

Out of the Transport Fund the Minister is to make payments to the Commission in respect of the loss incurred in the disposal of the road haulage property, the loss of net railway revenue caused by the transfer of goods traffic from rail to road and compensation payable to officers and servants of the Commission in consequence of the disposal of the road haulage property.

The Bill provides for the submission to and approval by the Minister of a scheme for the reorganisation of the railways. The scheme is to provide, in particular, for the establishment of area authorities and there is to be an authority for the whole of Scotland.

Sections 63 and 64 of the Transport Act, 1947, which provide for the making by the Commission of area passenger road transport schemes, are to be repealed, as is also Section 65 in so far as it exempts the Commission from the requirements of the Road Traffic Act, 1930, relating to road service licences. In relation to the London Area the Commission will be in the same position as the London Passenger Transport Board was in under the London Passenger Transport Act, 1933. The Commission is to lose the power to acquire passenger road transport undertakings and the acquisition and retention by the Commission of controlling interests in companies carrying on such undertakings are to be subject to control by the Minister.

Sections 66 to 68 of the Transport Act, 1947, which provide for the making by the Commission of schemes for trade harbours, are to be repealed.

Section 77 of the Transport Act, 1947, relates to the contents of charges schemes. Clause 19 restricts the charges to which the schemes are in future to relate and limits the provisions of the Section as respects charges. Clause 20 provides for the protection of competitors against charges made with a view to eliminating competition and for the protection of traders in the matters of equality and undue preference. The Commission is to have conditional freedom to effect general increases of certain classes of charges above the limits set by charges schemes.

The constitution of the Commission and its general duties as defined by Section 3 of the Transport Act, 1947, are to be modified.

The provisions of the Transport Act, 1947, relating to the borrowing powers of the Commission (Section 88) are modified so as to substitute for the existing limits a limit of £275,000,000 on amounts outstanding at any time in respect of all borrowings other than those required for the purpose of paying compensation in respect of the transfer to the Commission of undertakings under that Act: borrowings for the redemption of stock or the repayment of temporary loans may be made in excess of the limit.

Provision is made for the Commission to engage, notwithstanding certain restrictions set out in the Transport Act, 1947, in activities in the interests of national defence, when authorised or directed by the Minister to do so, if the work required cannot otherwise be carried out without serious delay or loss of efficiency.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 24, Victoria Street, London, S.W.1.

SIZES OF X-RAY FILM AND INTENSIFYING SCREENS

No. 1443 : 1952. This standard relates to X-ray material for medical and industrial use, other than dental X-ray films and X-ray films for crystallography, for which separate British Standards will be issued in due course. In preparing this new edition, a review has been made of the schedule of nominal sizes, and it has been found desirable to include two additional sizes, namely, 11in by 14in and 15cm by 40cm. Minor adjustments have been made in respect of the tolerances on the cutting sizes of the films and, where the nominal sizes are the same as those for photographic sheet film, as specified in B.S. 1772, the cutting dimensions and tolerances have now been brought completely into accord in these two standards. Reference to the internal dimensions of cassettes has been omitted, as it is intended to prepare a separate British Standard for the dimensions of cassettes. The method of marking packaged films and screens is indicated. Price 2s.

Oil Industries Club.—Earlier this month, Mr. D. C. Ion, B.A., gave a talk, entitled "How Little We Know," to the Oil Industries Club, during the course of which he discussed how oil was formed, the migration and accumulation of oil, and the problems of production; and pointed out some of the unknowns and the gaps in existing knowledge.

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TRANSPORT AND THE TRANSPORT BILL

IT is a peculiarly apposite accident of timing that the Annual Report of the British Transport Commission should have been published within a few days of the appearance of the Government's Transport Bill. For the former contains facts, figures and arguments, many of which have a very pertinent bearing upon the terms of the Bill. The Report reveals, not only what the Commission did in the year ending December 31st last, but what it hopes and has been planning to do. Naturally enough, the Commission sees more clearly the virtues than the defects of unified control of all forms of transport. As was the intention of those who set it up, it is striving after the provision of a commercial service which does not confine itself only to the operation of the more profitable routes or the carriage of the more profitable goods, but which, subject to making no overall loss, provides suitable transport as needed in all and every area. Implicitly and sometimes explicitly the Report criticises the situation that existed before it was set up, in which private road hauliers did not have laid upon them the obligations carried by the railways to haul virtually all classes of goods at all times; to operate regular services, not always financially profitable; to give all users equal treatment under similar conditions; and to apply uniformly an approved tariff. Thus they were able to select traffics and, because entry into the industry was limited by licence, to operate under conditions which were not those of free competition. By not so discriminating between traffics, by financing a large-scale network of facilities and by supporting "poor areas" out of others, it is contended, British Road Services have tended much more closely to conform to the requirements of a true public service in long-distance haulage.

Again the Report reveals how necessarily long must be the time taken to bring about that "integration" of road, rail and other transport services that it is the object of the Commission to attain. For instance, for the efficient operation of many thousands of lorries in a single organisation new road haulage depots are needed. But under the present conditions of financial stringency which prevent new building and even very much conversion of existing premises, the best must be made of properties, some of which are bluntly labelled "entirely unsuitable." Similarly, large economies could be realised upon the railways were it possible, amongst other things, more rapidly to introduce freight trains made up of wagons fitted with automatic brakes and capable therefore of running at passenger train speeds. Nor was the limitation upon capital expenditure the only one operating during the year. Shortage of raw materials also imposed severe limitations upon the rate of progress. Such restrictions must also have hampered the work of attempting to formulate a goods charges scheme for rail, road and inland waterway services. For such a scheme must be based upon as clear as possible a knowledge of actual costs of carriage by the various forms of transport concerned. An appendix to the Report, entitled "Some Notes on Traffic Costing," makes it very clear how complex costing calculations actually are even under stable operating conditions. How much more difficult they must become and how much more liable to error when road vehicles operate from ill-equipped depots, rail speeds are limited by insufficient track maintenance, and financial restrictions and raw material shortages impose unpredictable delays upon the rate of improvement! The integrated charges scheme, after discussions between the Commission and the Traders' Co-ordinating Committee on Transport and other bodies representing users and providers of transport and also with the coastal shipping representatives did get so far in 1951 that the Commission can claim in this Report that "a large measure of agreement was reached." But we are left incapable of judging the meaning of those words. For in view of the transport policy of the present Government the Commission has decided to defer the submission of a draft scheme to the Minister.

We proved critical when, a few weeks ago, a White Paper revealed what were to be the Government's proposals for "denationalising" transport. This Report makes us feel the more assured that we were right to criticise. For though we are by no means satisfied that the nationalisation of long-distance road haulage was well-advised, we also hold that there is no system of operating transport (or any other business) worse than one of "chop and change." In effect the Conservative Government has expressed an intention to reverse an action of the previous Government. It can therefore hardly blame the Opposition if it threatens to renationalise as soon as it attains the power to do so. The policy now needed is not a controversial one but one about which substantial agreement can be reached by both parties in the State. That agreement, so it seems to us, is only likely to be realised by accepting that the bulk of long-distance road haulage concerns and a number of road passenger carrying concerns have been taken over and are in course of digestion by the Road Haulage Executive, that the previously existing railway groups are in course of being welded into British Railways, and that the British Transport Commission, not wholly without success, is endeavouring in various ways and at considerable expenditure of capital to "integrate" transport of all kinds into a single "service." Modification of the organisation in the light of four years' experience may, indeed, be called for. Should the Road Haulage Executive, for instance, be permitted to retain its monopoly of long-distance road haulage? Were that monopoly destroyed could the Commission create that road transport "service" to the community at which it is aiming, despite competition from private "A" licensees as well as numerous existing "C" licensees? To what extent could decentralisation of railway operation be carried without hindering the beneficial standardisation now being pushed forward? Is it really practicable to draw up a charges scheme covering satisfactorily all forms of transport? A study of those and many other questions of more detail (many of them already being studied by the Commission itself) would, we feel, prove far more eventually advantageous than any attempt now to restore the *status quo ante* nationalisation with its consequent danger of stinging the Opposition into renationalisation at the first opportunity. For the sooner transport ceases to be a subject for party controversy the better and, providing adequate criticism can be brought to bear upon it, an established stable nationalised transport system is at least certain to prove more efficient than a privately owned system, whose security of tenure extends only until the uncertain date of the next election.

METALLURGISTS IN METAL-USING INDUSTRIES

SINCE the first world war an increasing number of metallurgists has been employed in various branches of the engineering industry. Prior to 1914 the metallurgist was almost completely concerned with the production and improvement of metals, alloys and metallic products, which were purchased by the user under some more or less satisfactory specification or guarantee. The user was in most cases wholly responsible for the

choice of material and for making the correct use of the product. It is true that the purchaser often sought the advice of the producer in these matters, but there was no formal means of co-operation. Even at that time many large engineering firms employed metallurgists to attend to their special metallurgical interests, but it has taken many years to secure recognition of the day-to-day help which metallurgists can give to industries which, though not strictly metallurgical, are dependent on the supply of metal of adequate quality for constructional or manipulative purposes.

Mr. Vernon Harbord, in his presidential address to the Institution of Mining and Metallurgy, dealt with the value of the metallurgist to kindred professions and outlined the wide field in which the metallurgist could render important service in many industrial undertakings not directly concerned with the production of metals. With the continuous improvement and ever-increasing complexity of metallurgical products, the guidance which may be afforded by a well-trained metallurgist to the engineering designer will become an even greater necessity in the future than in the past. Advantages offered by some new product in one direction are often offset by difficulties or disadvantages in another. There are standards to be observed in the design and surface finish of components made from modern alloys of high mechanical properties which might have been thought unnecessary in the more common grades of material. The variety of alloys now available for constructional purposes involves risk of corrosion which must be carefully studied in any design. Control and recording of the metallurgical features of all materials employed in a prototype are of great importance. Mr. Harbord was able to give relevant illustrations from his own experience as a metallurgical consultant and as an adviser to the Armaments Design Department during the war. Not only in the choice of materials, but also in the maintenance of plant of every description, the metallurgist can play an important part. Mr. Harbord put forward cogent arguments to show that in an undertaking of a solely mining character the employment of a metallurgist would more than justify itself by the reduction of maintenance costs and of consequential damage resulting from preventable breakdowns. The logical position of such a man would be on the maintenance staff under the chief engineer. Though Mr. Harbord was speaking particularly to mining engineers, his remarks might be applied to nearly every recognised branch of engineering.

Engineering metallurgy has, to the advantage of both metallurgists and engineers, been the subject matter of many admirable textbooks. They have the great merit of discussing the behaviour of materials in factual terms relatively free from technicalities; but no degree of acquaintance with these books by the metal user can replace the need for a metallurgist with a much wider background of knowledge and practice if the full advantages of co-operation are to be attained. Nor do the excellent services of the various metallurgical development associations meet all requirements. They, in fact, make it the more essential that the metal user should be in a position to state his metallurgical requirements and make his own contribution to the solution of his problems. The metal user's metallurgist, apart from dealing with many such problems directly as they arise, can facilitate the application of new products and improved treatment and should be able to advise metal producers of the direction in which they might best meet the needs of the user whom he represents. To secure such co-operation between producer and user, both links in the metallurgical chain are indispensable.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

BRITISH LOCOMOTIVE PERFORMANCE AND EFFICIENCY TESTS

SIR,—There are many points of interest in Mr. Nock's article concluded on page 64, and while discussion in detail is hardly possible in reasonable space, I should like to remark on a point of general principle in reporting test results.

Many of the coal consumption figures in these bulletins are very much lower than those quoted in the past for locomotives of generally similar character. For the "B 1" 4–6–0, for example, page 30 gives figures ranging from 2·18 lb to 3·15 lb per drawbar horsepower-hour for outputs ranging from 600 to 1000 d.h.p., whereas in the 1948 locomotive exchange, the same class of engine, working at power outputs generally within that range, gave coal consumptions ranging from 3·32 lb to 4·01 lb per drawbar horsepower-hour. (I quote these figures as published; I do not believe that the last digit in 4·01 has any meaning.)

These fairly wide ranges of consumption do not even overlap, and it seems to me that the report should comment on the difference between them, if only to confirm that the later figures have been compared with the earlier ones, which are in line with published figures for several classes of British locomotive. Any known reason for the difference should preferably be stated. Failing that, some possible explanation might be mentioned or, failing that, it would be appropriate to remark that at the time of completing the report, no satisfactory explanation had beeen found.

It is common to discover, on examining details of tests that have produced a startling result, that an error has been made at some point or other, and that the corrected result is much less remarkable. It seems improbable that these particular locomotive test figures contain errors other than the unavoidable experimental ones, but it is noteworthy that the coal consumptions per drawbar horsepower-hour are about the same as those previously recorded in Great Britain on the basis of indicated horsepower-hour.

On page 62 is a statement that arrests the attention by its disagreement with normal understanding of the subject. By comparison with a speed of 50 m.p.h. on the level with 300 tons (involving, according to Fig. 12, 3 lb of coal per drawbar horsepower-hour), the text states that "it is more economical to run faster on the level since the coal per drawbar horsepower-hour at 70 m.p.h. is only 2·8 lb."

The suggestion that coal may be economised by running at 70 m.p.h. instead of 50 m.p.h. is so accurately opposed to practical experience (no footplate man would believe it whatever tests might appear to show) that re-examination is demanded. It seems to have been overlooked that the drawbar horsepower required at 70 m.p.h. is about twice that at 50 m.p.h. (according to Johansen 2·6 per ton at 70 and 1·35 at 50). When this is taken into account the consumptions per ton-hour are found to be 7·3 lb at 70 m.p.h. and 4·1 lb at 50 m.p.h., and per ton-mile they are 0·104 lb at 70 m.p.h. and 0·082 lb at 50 m.p.h. Thus the test results provide a quantitative measure of the fuel cost of high-speed and they do not conflict with general experience that, over about 40 m.p.h., faster running demands more coal.

W. A. TUPLIN, D.Sc., M.I.Mech.E.

Sheffield, 10,
July 11th.

Bursaries in Public Health Engineering

THE Institution of Civil Engineers has accepted an invitation from the Rockefeller Foundation, Division of Medicine and Public Health, to administer during the next three years certain moneys for use in providing bursaries for post graduate study and research in public health engineering in universities in the United Kingdom, and has appointed an awards committee for the purpose. Each bursary of approximately £450 per annum will normally be tenable for one year, but may be renewed at the discretion of the awards committee. The amount of the award may be appreciably increased in special circumstances to older applicants of experience. Applicants must hold an engineering degree of a University within the Commonwealth, acceptable to the awards committee, and awards will be made to individuals who wish to take a course of study or research in public health engineering at a University in the United Kingdom having facilities for such study or research.

Applications for these awards will be considered from graduates who have just completed their degrees, or from graduates who have had practical experience in the field of public health engineering. Awards may also be made to graduates wishing to undertake research on a specific subject in the field of public health engineering. A successful candidate must not undertake work other than his course of study without the permission of the awards committee, and will be expected to submit an account of his work to the Institution at the conclusion of the course. It is important that applications for the 1952–53 bursaries should be received by the Secretary, the Institution of Civil Engineers, Great George Street, Westminster, S.W.1, as soon as possible, and in any case not later than August 31st.

BOOKS RECEIVED

Modern Naval Architecture. By W. Muckle. London: Temple Press, Ltd., Bowling Green Lane, E.C.1. Price 9s. 6d.

The Science of Flames and Furnaces. By M. W. Thring. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 42s.

The Welding of Non-Ferrous Metals. By E. G. West. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 55s.

Werkstattbucher: Einbau and Wartung der Walzlager. By W. Jurgensmeyer. Berlin: Springer-Verlag, Berlin. Price 3.60 Dmk.

Landlord and Tenant. By R. Borregaard. London: Stevens and Sons, Ltd., 119–120, Chancery Lane, W.C.2. Price 6s.

Forms of Public Control and Ownership. By Edward Goodman. London: Christophers, 22, Berners Street, W.1. Price 8s. 6d.

Advanced Theory of Waveguides. By L. Lewin. London: Iliffe and Sons, Ltd., Dorset House, Stamford Street, S.E.1. Price 30s.

Encyclopædia of Oxy-Acetylene Welding. By L. J. Tibbenham. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, W.C.2. Price 10s. 6d.

Gears: Spur, Helical, Bevel and Worm. By P. S. Houghton. Kingston: The Technical Press, Ltd., Gloucester Road, Kingston Hill, Surrey. Price 50s.

Fractional H.P. Electric Motors. By F. G. Spreadbury. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 35s.

The Resistance of Piles to Penetration. Second edition. By Russell V. Allin. London: E. and F. N. Spon, Ltd., 15, Bedford Street, Strand, W.C.2. Price 21s.

Literature

Technological Applications of Statistics. By L. H. C. TIPPETT. London: Williams and Norgate, Ltd., 36, Great Russell Street, W.C.1. Price 18s.

THIS book is an edited reproduction of a series of lectures given in 1948 to an audience, which consisted mainly of engineers and specialist technicians, at the Massachusetts Institute of Technology by L. H. C. Tippett, of the British Cotton Industry Research Association, author of *The Methods of Statistics*. The book is divided into two parts, which differ considerably in matter and manner—Part I, "The Routine Control of Quality," and Part II, "Investigation and Experimentation."

Part I, "The Routine Control of Quality," is a general introduction to the statistical quality control chart and statistical sampling which is useful to the engineer, metallurgist, chemist and physicist. It is elementary in treatment and largely consists of restatement of existing information with little attempt at additional original material. Full and generous references are made to the sources. It is interesting to note the assembly, probably for the first time, of the British and American points of view on quality control. This is useful as there are differences in these points of view which have been puzzling in the past to the beginner who has used both American and British textbooks. One of the sources mentioned is the *A.S.T.M. Manual on Quality Control of Materials* published by the American Society for Testing Materials, one of the very few works on industrial statistics written by engineers for engineers. If *Technological Applications of Statistics* goes to a second edition, it is hoped that the author will revise all those sections where he arrives at a difficult point and blandly refers the reader to "the textbooks." He should either explain the point, and that is the suggested solution, or give a specific reference. In this matter the author is too modest; in all cases where a difficult point is lightly passed over, the explanation can be found in his *The Methods of Statistics*.

Part II is entirely different. Under the heading "Investigation and Experimentation," the author examines the use of statistical significance tests, analysis of variance, and correlation analysis, mainly from the important point of view that these methods must be used by statisticians with due care and with full use of all the special technical knowledge which may be available. The point is made that in industry a little statistical knowledge may be highly dangerous and that purely statistical inference without careful accompanying technical thinking is useless. In this section in which all the examples are of a practical character, taken mostly from the textile and steel industries, the author fortunately forgets to be extremely elementary and the result is all the more interesting and just as comprehensible.

An important section of Part II deals with the industrial aspect of what the statistician, for convenience, calls "Errors of the First and Second Kind." A paraphrased version of the definition given in the book is as follows:—In testing whether a difference is, on the one hand, "significant" or real, or, on the other hand, "not significant" or accidental, we calculate a probability and check this against a selected level. If the calculated probability is above this level the difference is accepted as "significant"; if below the level it is rejected as "not significant." In making this test we may err in one of two ways:

(1) The verdict may be "significant," although the true difference is zero, or (2) the verdict may be "not significant," although there may be a real difference.

In general, it may be said that the error of the first kind is associated with a decision to act, and that the error of the second kind is associated with a decision not to act.

The author points out that the risk of making an error of the first kind—that of wrongly accepting a difference as "significant," may be made as low as we please by choosing a sufficiently low probability P as the level of significance," but that "unfortunately, the lower the value of P the greater is the risk of the second kind of error, that of overlooking a real difference." The statistician can be over cautious in his recommendations. The level of risk adopted will, in fact, depend on the balance between the penalties for wrong action and wrong inaction. If, for instance, one is considering installing new plant and the potential saving is enormous compared with the cost of the plant, the level of acceptable risk can be high. The existence of both kinds of error, that one may be wrong if one takes action, and one may be wrong if one does not take action, is no news to any industrialist, but the fact that the risks involved must be balanced has not been hitherto emphasised in literature on industrial statistics.

Part II also includes a critical examination of various assumptions that can be made by the industrial statistician without sufficient justification, such as equal variability, randomness in the selection of data, &c. This section is particularly interesting as it has frequently been found that it is highly risky to assume that industrial data are either homogeneous or randomly selected. On one disastrous occasion, a result confidently presented to a committee was entirely wrong because the general conditions of working of the open-hearth furnace concerned had been radically changed halfway through the period during which the data were obtained without notification.

Another useful section of Part II deals with economy in statistically planned experiments. It is the justifiable claim of the "planned experiment" that it will yield more pertinent information than the traditional step-by-step experiment. If, however, it is necessary to make provision for many factors, the statistical purist will call for a very elaborate plan which may well prove to be too expensive or too slow for actual use. This does not rule out the statistical approach since legitimate short cuts are available, and the author does service by giving guidance in this direction. The following are relevant quotations:—

"Over what range should the experimental factors be varied? The short answer is: over the range of practical interest, having regard to the future as well as the present. Two kinds of knowledge are required to arrive at the most economical arrangements: statistical and technical. Technical knowledge can help in suggesting where variation is likely to lie, the relative costs of performing different parts of an experiment, &c."

The above notes do not pretend to be an exhaustive examination of an interesting book. They indicate, however, that *Technological Applications of Statistics* is uneven, but helpful and stimulating, and that its virtues far outweigh its faults.

Locomotives and Their Working. By C. R. H. SIMPSON and F. BROWNE ROBERTS. London: Virtue and Co., Ltd., Buchanan Buildings, 24, Holborn, E.C.1. Price £3 10s.

THIS book is in two volumes and is largely a description, with many excellent illustrations, of details of construction of steam locomotives. Interspersed in the descriptive parts are many comments on points of immediate interest to running-shed staff or enginemen (for whom the book is primarily intended) and this must be taken into account when it is noted that only thirty pages, out of a total of 550, are specifically devoted to preparation, running, firing and disposal of locomotives. In the chapter on "Cylinders, Pistons and Valves," for example, the tracing of faults from the evidence of intermittent "blows" is examined quite closely.

There are, however, omissions of practical detail. It is mentioned, for example, on page 393, that the fire on a sloping grate may be shaken down to the front by a rough road or by the strong draught that accompanies violent slipping. In such circumstances the fireman is recommended to "pull back" the fire, but no suggestion is made as to what implement to employ or the time required to do it. This book repeats (page 387) the very old remark that more firemen have come to grief from carrying too thick a fire than from one too thin, but this may mean merely that thin fires are very rarely used. A thick fire is safer in that it will tend to correct itself if left alone, whereas an excessively thin fire rapidly becomes thinner unless quickly fed. On page 390 it is mentioned that "Misuse of the dampers will hasten clinker formation" without defining "misuse." It is feared that one example is an earlier recommendation that "Dampers should always be used to check blowing-off." It might have been mentioned that the driver's equalising brake valve in the Westinghouse brake equipment enables him to use exactly the same handle movements for a desired retardation whatever the length of the train. On page 213 occurs an incorrect statement that the use of a rocking lever in conjunction with Stephenson valve gear reverses the direction of variation of lead with notching-up. The truth is that if in reversing the engine, the links have to be moved round the crank axle in the desired direction of rotation of the axle, the lead increases with shortening of cut-off. This is the usual condition, the links being set in the lowermost position for full forward gear; otherwise the lead decreases with shortening of cut-off. This rule applies for inside or outside admission with or without rocking shaft.

In referring to the conjugated valve gear traditionally associated with the name of Gresley, it is stated that lost motion and whip cause the inside cylinder of a three-cylinder engine to develop less power than an outside cylinder. This is true at low speeds, but the opposite is the case above the speed at which inertia forces on the valve exceed the frictional forces because backlash then leads to "gained motion" instead of "lost motion" and this is a common running condition for an express passenger engine. Poppet valves are said to give quicker opening than piston valves, but this difference is due not to the valves but to the fact that the former are usually

worked by cams and the latter by linkages giving a close approximation to simple harmonic motion. It is the form of the valve gear that decides how quickly the valve may open or close and either type of valve might be worked by either type of gear.

Although the book is not intended as a technical treatise one regrets to encounter again such time-honoured misconceptions as "The smaller the wheel the better the rate of acceleration" (page 12), and the tacit assumption, in discussing adhesion factors, that it is impossible to have a steam chest pressure lower than the rated maximum boiler pressure. On page 198 it is said that the reciprocating parts are subjected to a shock when their movements are reversed at the dead centre. In actual fact, shock due to the taking up of backlash occurs at instants determined by resultant steam pressure on the piston and the acceleration it would require in order to maintain its nominal position in relation to the crank-pin. When drifting at high speed, for example, shock occurs soon after mid-stroke. It is only at low speed that shock occurs near dead centre and in that condition the admission of live steam does nothing to reduce the shock substitute but is, in fact, the cause of it.

Near the end of the book are descriptions of some typical modern steam locomotives. It would save space and time if the dimensions were concentrated in a single table instead of being distributed in the text. It is not flattering to the Eastern Region "K1" 2-6-0 to say that it is capable of performing work previously carried out by the "J39" 0-6-0 (a smaller engine) and it is doubtful whether in 1952 the Western Region "Kings" "still rank among the most powerful passenger locomotives in Great Britain."

The book is well produced, readily readable and fully provided with diagrams appropriate to its purpose.

Reinforced Concrete. By OSCAR FABER, C.B.E., D.C.L. (Hon.), D.Sc. London: E. and F. N. Spon, Ltd., 15, Bedford Street, W.C.2. Price 30s.

MANY in the building and allied professions have been grateful for Dr. Oscar Faber's book, "Reinforced Concrete Simply Explained." The concise and lucid explanations of the basic principles given in this book have formed the foundation of many a career and enabled students to acquire at the outset of their studies a grasp of fundamentals and a confidence in their application. Dr. Faber's new book is in the nature of a very much expanded version of "Reinforced Concrete Simply Explained." In the course of seventeen chapters the author ranges over almost the entire field of reinforced concrete, including modern techniques, such as shell construction and prestressed concrete.

The reader who is not seeking a text book which deals fully with the mathematical aspects of reinforced concrete theory and the analysis of reinforced concrete structures will find in this book a very readable and comprehensive survey of the fundamentals of reinforced concrete including a thorough discussion of the materials used and their behaviour in reinforced concrete members. The author deals clearly with shrinkage and creep and other aspects of concrete which sometimes create difficulties. Throughout, his arguments and descriptions are supported by experimental data, many of which were obtained by the author, and the author's wide experience of reinforced concrete structures is freely drawn upon. The text is related to the recommendations of the British Standard Code of Practice CP.114–1948, and explains some of the points therein which puzzle most users. Incidentally, Dr. Faber was chairman of the committee which drafted the Code.

The book does not attempt to deal fully with the standard theory of reinforced concrete, although there are a number of useful graphs, formulæ and tables. In the preface the author makes it clear that he is impatient with much that passes for accurate calculation in reinforced concrete design and approaches the problems dealt with in the book on the basis of direct application of the fundamental principles. His treatment of combined bending and direct stresses is particularly unusual and interesting. In solving this problem he makes no use of the graphs and other data with which engineers have long been familiar, but instead solves the problem from first principles by a method of trial. While this is a welcome departure from the point of view of those who are not continually engaged in calculation it detracts somewhat from the value of the book as far as the designing engineer is concerned.

It is unfortunate that the author has retained a term for inelastic deformation of concrete which appeared in earlier works in preference to the now generally accepted term "creep": he refers to "plasticity" and "plastic yield" of concrete, which is confusing to the reader, who may suppose that such deformation resembles the true plastic yield of metals. Another minor criticism is that some of the diagrams, in particular certain graphs, have not been prepared with a view to clear reproduction in a book. Perhaps also the author has been a little rash in his discussion of the economics of reinforced concrete in relation to other forms of construction, as such arguments tend to "date" a book very rapidly.

Despite the criticisms and a certain disappointment which designers will feel that their particular problems have not received more detailed consideration, this book remains a valuable contribution to the literature of reinforced concrete and will be welcomed by architects, clerks of works, surveyors and students in the building and civil engineering industries.

SHORT NOTICES

Waves and Tides. By R. C. H. Russell and D. H. Macmillan. London: Hutchinson International Authors, Ltd., Stratford Place, W.1. Price 25s.—The first half of this book, by the first author, is on waves, and the second half, by the second author, is on tides. In both cases a fairly full account is given of present theoretical knowledge of the subject, and of the characteristics of waves and tides found in Nature. There is a chapter on the movement of material by waves in Part I, and also one on the effects of waves on structures, and one on wave measuring. In the second part the topics discussed include the mutual influence of tide and weather, the effects of tides on the navigator, and on the development of sea power. The utilisation of tidal energy and the future of tidal research are also discussed. The material is presented in an interesting form, topics of more general interest being interspersed with the theoretical accounts.

Radio, Vol. I. By John D. Tucker and Donald F. Wilkinson, B.Sc (Eng.), A.M.I.E.E. London: English Universities Press, Ltd., St. Paul's House, Warwick Square, E.C.4. Price 7s. 6d.—Being written specially for students preparing for the City and Guilds examinations in radio, this book follows closely the syllabus of the subject "Radio I," and it contains the fundamental information necessary for the Radio Amateurs' Examination. To avoid repetition of the text required for the corresponding stage of the telecommunications syllabus the authors have omitted this portion of the subject from the book under review. For the fundamental electric circuit theory, which is required for full understanding of radio, the reader should study *Telecommunications (Principles)*, Vol. II, in conjunction with *Radio*, Vol. I. The book is divided into chapters dealing, respectively, with electricity and magnetism, radio communication, aerials and tuning, components and valves, a.f. and r.f. amplifiers, power supplies, oscillators, modulation and detection, receivers and measurements in radio work. Some numerical examples and the appropriate answers are given.

Civil Engineering Plant and Methods. By Rolt Hammond. London: Ernest Benn, Ltd., Bouverie House, Fleet Street, E.C.4. Price 25s.—The various topics discussed in this book are grouped under ten chapter headings of excavating plant; piling and foundation plant and methods; concrete mixing and placing equipment; cranes and lifting appliances; plant for dock and harbour construction; tunnelling methods and equipment; unit construction in civil engineering; welding in civil engineering; roadmaking machinery; and the organisation of civil engineering work. Since each one of these chapters could be expanded to fill a volume, it is evident that there must be some subjects which appear to be treated superficially, or even omitted. Nevertheless, an agreeable overall account of modern civil engineering plant is given within the space of about 220 pages, which will be of value particularly, we think, to civil engineering students.

A Bibliographical Survey of Flow Through Orifices and Parallel-Throated Nozzles. By T. H. Redding. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 3s. 6d.—This work forms the British Scientific Instrument Research Association's publication M9. The bibliography covers the period 1832–1946 and deals with literature relating to theoretical and experimental investigations on the flow of liquids and gases through orifices and nozzles, in so far as they deal with freely discharging, intake and pipe orifices, and similar arrangements of parallel throated nozzles; papers dealing with partially drowned orifices, fully drowned orifices (other than pipe orifices), non-parallel-throated nozzles, and differential manometers are not reviewed. The work includes introductory notes and explanations of the terms and symbols used, with such information as tables on early theoretical or experimental investigations. The bibliography is classified under sixteen subject headings.

Cross Channel Electricity Supply Link

IN the debate on fuel and power, last week, the Minister of Fuel and Power, Mr. Geoffrey Lloyd, referred to the joint committee of the British Electricity Authority and Electricité de France, which has been studying the possibility of laying a submarine power cable under the Channel to connect the electricity supply systems of the two countries. Mr. Lloyd went on to say that the British Electricity Authority was engaged in considering the committee's report. Last Monday the Authority issued a statement expressing approval in principle of this interim report. In particular the Authority has adopted the joint committee's recommendation to undertake a development programme, and has authorised an expenditure up to £125,000 for the purpose. It may be recalled that one of the commercial advantages of a cross-Channel cable would arise from the fact that the peak hours take place at different times in the two countries, and the cable link would open up the prospect of power flow from one country to the other at peak periods, to compensate for a shortage of installed plant capacity. Accordingly, power might be transmitted alternately from the French Alps to this country and from the thermal stations of the East Midlands to France.

Steel Tube Production by Electric Resistance Welding

There is now in operation, at the Corby Works of Stewarts and Lloyds, Ltd., a plant for the manufacture of boiler and superheater tubes by electric resistance welding. Whilst the process is not a new one, it has hitherto been used primarily in this country for making steel tubes for mechanical or non-pressure purposes. The plant at Corby has been operating for just over a year, and, although it is difficult to give a detailed production figure, the average output is said to be about 1000 tons a week.

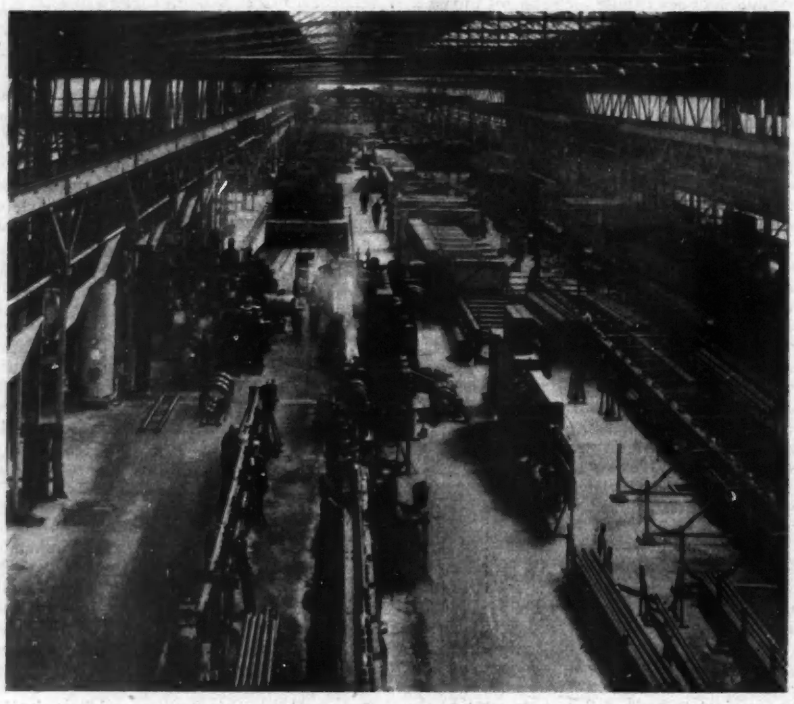
WE were invited recently to spend a day at the Corby Works of Stewarts and Lloyds, Ltd., to see, in particular, the plant which has been installed there for making high grade steel tubes by the electric resistance welding process. Although the process is not new to this country, it is only comparatively recently that it has been developed—in the U.S.A.—to a point at which high-quality tubes, such as boiler tubes, can be produced. This development has been brought about largely by the Babcock and Wilcox Company of America, the main difference between the new process and the old being the use of a comparatively high frequency alternating current to provide the most consistent welding conditions. Before deciding on the process which it is now operating, Stewarts and Lloyds, Ltd., examined many tubes made in the U.S.A. from American steel, and also sent to the Babcock and Wilcox Company of America a quantity of Corby steel to be made into tubes. When these tubes were returned to Corby, they were subjected to over 2000 tests, which assured Stewarts and Lloyds, Ltd. of the high quality of the product.

For tubes, such as boiler tubes to meet the requirements of B.S. 1654 and B.S. 1678, it is essential that the weld should be as strong as the parent metal and consistently good throughout its whole length. At Corby, this is being attained by constant attention to the correct working conditions and by ensuring that there is complete uniformity between the steel and the tube making process. Stewarts and Lloyds, Ltd., is well placed in this matter as for steel making at Corby it uses scrap arising in the works and iron made direct from local ores. By using these materials, it is possible to see to it that the steel for tube making is free from elements that would be undesirable from the welding point of view. The steel usually employed has a minimum tensile strength of 20 tons per square inch, with a minimum yield point of 11 tons per square inch, though higher tensile steels may be used. Throughout both the steel making and tube making processes the company's inspectors are stationed at various points, and are authorised to stop production at any stage in manufacture if the product should be considered unsatisfactory.

The Open Hearth Steel Plant

Before proceeding to a description of the electric resistance welding of tubes, it is appropriate to make some reference to the open hearth steel plant at Corby, which is one of the company's contributions to the steel industry's development programme. This plant is housed in a modern building 328ft long by 261ft wide, in the construction of which allowance has been made for extension in either direction. The whole arrangement permits plenty of space for every operation. There are two 100-ton fixed open hearth furnaces, supplied by the Wellman Smith Owen Engineering Corporation, Ltd., and designed for firing with either liquid fuel (oil or tar) alone, a mixture of blast furnace gas and liquid fuel, or a mixture of mixed gas and liquid fuel.

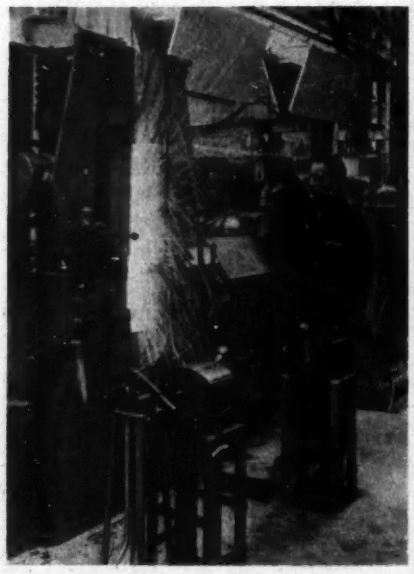
The scrap bay is 97ft wide by 78ft to the eaves, and is serviced by two 35-ton overhead cranes, which handle charging boxes on cradles from the charging bay floor to the bench. The furnaces are charged by a 5-ton floor charger, and during our visit we were informed that the charge consists of 65 per cent scrap and 35 per cent pig. The furnace bay is equipped with one 15-ton and one 120-ton overhead crane, the latter for duplexing hot metal, and the casting pit is serviced by a 160-ton crane for casting and a 15-ton overhead crane for general duty. Two waste heat boilers attached to the furnaces are



PLANT FOR ELECTRIC RESISTANCE WELDING PROCESS

PICKLED COILS ENTERING COLD ROLLING MILL

capable of raising between 7000lb and 14,000 lb of steam per hour at a pressure of 195 lb per square inch and a temperature of between 500 deg. Fah. and 580 deg. Fah, or 25,000 lb of steam an hour with auxiliary burners in operation. An auxiliary boiler, burning either liquid or gaseous fuel, is likewise capable of producing 25,000 lb of steam an hour. The excess steam not required for tar atomisation at the furnaces themselves, is used to boost the works' low pressure steam supply. The plant operates continuously, each furnace being able to produce about 2000 tons of high grade steel weekly. In the electric resistance welding process of tube making at Corby, all the strip used is of open hearth steel and is cold rolled to ensure good finish and accurate dimensions.

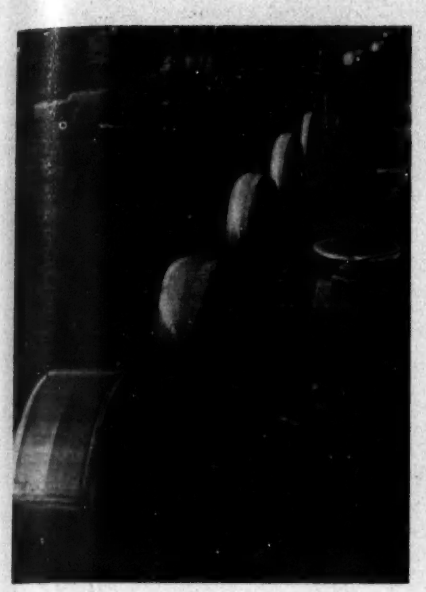


FLASH WELDING COILS TOGETHER

The Electric Resistance Weld Process

Two practically identical electric resistance welding plants have been installed at Corby, the only outstanding difference between them being in the size of tubes which each can produce. Tubes from 1in to 4in outside diameter are now being manufactured in lengths up to 36ft. A general view of one of these plants is shown in an accompanying illustration, and the principal particulars of both plants are set out in the table on page 95.

The strip for tube making arrives from the hot mills in coils, and is first descaled by its passage through a series of rolls which bend it alternately up and down, cracking off all the



FORMING ROLLS

scale and dirt. After the strip is rewound, the winding gear is reversed so that the turns of the coils are loosened to ensure that, in the subsequent pickling operation, the acid has free access to all surfaces. The loosened coils are turned into a horizontal position and are conveyed to the pickling plant where they are immersed in hot sulphuric acid to remove any traces of scale, rust or grease. The coils are then washed and returned to the vertical position preparatory to the cold rolling operation. The ends of the coils are fed into the cold rolling mill—as illustrated herewith—which gives the strip a cold pass. This operation, in addition to reducing the thickness by about 10 per cent creates a fine surface finish, produces uniformity of thickness across the width of the strip, and also ensures close thickness tolerances. A continuous check is maintained on the thickness of the cold rolled strip by "flying" micrometer control on the outgoing side of the rolls.

The surface of the cold rolled strip is oiled to protect it as it leaves the cold rolling mill, and the strip is then conveyed to the tube mill.

Principal particulars of E.R.W. Tube Plant

		No. 1 Mill	No. 2 Mill
Basic Size Range :	o.d. ...	1¼—2	2—4
	Thks. max.	7g	5g
Speed : ft per minute		up to 120	up to 100
Coil : weight, lb		2000	2000
length		200 to 1000ft	depending on thickness
Max. tube lengths :			
off mill		36ft.	36ft.
off sink bench		50ft.	50ft.
Forming Mill :			
h.p.		60	75
Number of stands		9	9
Welding Mill :			
5ocy volts		4—5	4—5
amps....		up to 40,000	up to 40,000
motor alternator, kVA ...		250	500
frequency		200	350
Sizing Mill : h.p.		30	40
No. of stands ...		3	3
Normalising : atmos.		Partly burned moist blast furnace gas	
temp.		950 deg. Cent. quench at 300 deg. Cent.	
Sinking : speed		200 feet per minute	
lubricant		Wool fat	
max. sink, per cent.		30 per cent	

In order that the process may be continuous, it is necessary, of course, for each successive coil to be welded to the preceding one, which is done in the flash welding machine illustrated on page 94. Before they enter the welding machine, the coils are unwound through a skelp leveller, the rolls of which flatten the strip before the ends of the coils are cut square to present clean surfaces for welding. The flash of extruded metal which results from joining the coils together is ploughed off by pulling the strip through a pair of cutters, leaving a flush surface on the strip. At a later stage this "cross-weld" is cut from the tube and scrapped. The flash welding of the coils is an intermittent process, the strip being stationary during welding. It is therefore necessary to have a loop between the flash welder and the forming mill to provide a supply of strip to the latter which operates continuously. Before entering the forming mill, the strip is brushed by wire brushes and passes through an edge slitter, which trims it to exact width and gives fresh clean cut edges for the tube welding operation. A part of the mill is shown in one of our illustrations. It consists of nine sets of rolls, which gradually change the flat strip into tubular form by curving up the edges, pressing it down

REMOVAL OF OUTSIDE BEAD

in the centre, and eventually rounding it into cylindrical shape. A central fin on the last forming roll accurately positions the edges before welding.

The formed strip, with its abutting edges uppermost, then passes into the welding machine, in which a large copper double electrode wheel runs on the top of the tube, making contact with the edges on either side, the current passing down one electrode, crossing the edges before it passes into the other electrode. At this point, two side rolls maintain pressure on the tube, and the current passing across the junction heats the metal locally to welding temperature. As speeds up to 100ft a minute can be used, this heating is very rapid, with the result that not only is there little time for oxide to form, but the heat does not spread appreciably, and only a narrow incandescent line is formed along the top of the tube. Any surplus semi-molten metal is squeezed out of the weld by the pressure of the side rolls. Alternating current is employed for the process, but the frequency is increased from the 50 c/s of the mains to 200c/s or 350 c/s according to the size of the tube, to give the best welding conditions. The need for the increased frequency arises with the high welding speed used, as pulsations of current at mains frequency would cause intermittent welding. By increasing the frequency, the pulsations are so close together that welding is continuous. As a rotating transformer is used to feed the high current low voltage supply to the electrode discs only the lower current higher voltage primary supply has to be passed through the rotating slip rings. Immediately after welding, the external bead formed at the weld is trimmed off to a flush surface by a cutter on the outside of the tube—as illustrated herewith. A similar cutter to trim the internal bead is supported inside the tube by a long rod held from a point in the forming mill before the edges of the strip are brought together. Water sprays then cool the weld, and the tube passes into a travelling cut-off machine which cuts it into the required lengths, without stopping the tube.

For certain purposes, tubes are supplied in the as-welded or semi-bright condition, but where ductility is specially important, as, for example, in boiler or superheater tubes, normalising is necessary. For this operation, the cut tubes pass into a normalising furnace—shown in the illustration below—which is 256ft long, and in which heating occurs to the temperature necessary to restore a uniform structure. The tubes are then cooled slowly in an inert atmosphere which is adjusted to produce a blue-black surface. Generally, the tubes take about an hour to pass through the normalising plant, the actual period depending on their size and thickness. When the temperature is sufficiently low, a coolant is applied to the tubes to bring them down to room temperature and they emerge ready for straightening. This is effected by passing the tubes through diagonal rolls, after which they are ready for the various finishing operations. The tubes are then subjected to a thorough final inspection.

The number of basic sizes of electric resistance welded tubes is kept as low as possible, and where intermediate sizes are called for they are obtained by "cold sinking," or drawing through a die of the required finished size without the use of an internal plug. The reduction in outside diameter causes a slight thickening of the tube which is, of course, allowed for in the making.

NORMALISING FURNACE

Development of Military Radio Equipment

AN extensive programme is in hand at the Signals Research and Development Establishment, Christchurch, on the development of signals and radar equipment for troops and fighting vehicles. Last week arrangements were made for members of the Press to see some of this work and to witness certain demonstrations of equipment, within the bounds of present security restrictions.

Whilst briefly explaining the purpose of the Establishment, the Chief Superintendent remarked that unless signals equipment was absolutely dependable it were better not used at all. He emphasised that it was often the little things, such as broken head-phone cord or corroded battery terminals rather than main aspects of design, that had caused the failures in the past. Consequently, the engineering of ancillaries and details was therefore regarded at the Establishment as of equal importance with circuit design. Furthermore, extreme reliability was to be achieved in spite of the greatest possible reduction in weight, and in face of rough handling and climatic exposure of an order far different to that experienced by civilian equipment.

Development Division

Lines Group.—The Army's use of line equipment extends from the point-to-point telephone circuit over assault cable to large trunk telephone networks and from hand-keyed Morse over line to automatic telegraph machines.

This Group is concerned with the development of the lines themselves and the telephone and telegraph equipment (except the telephone subscribers' instrument) utilising these lines. The objective is to develop wire and cable with improved transmission characteristics for a given size and weight and to devise faster methods of laying cable or erecting overhead routes. Five new types of cable and three new types of pole route are being developed.

Amongst the items displayed was a field cable, laid from a dispenser coil. This arrangement side-steps the disadvantages of laying from a drum, i.e., extra weight and overrunning, and enables communication to be maintained during laying. A light pole route has been developed in mild steel, which employs poles in sections designed for quick erection, using a driven ground tube. The pole need not be stayed under light loading conditions.

The trunk telephone exchange which has been developed provides the operating facilities of a modern trunk switchboard and is, furthermore, constructed on the "unit" principle, which enables an exchange to be erected rapidly and dismantled into a number of easily transportable parts. Interconnection between these units is on a plug and socket basis.

Another item featured a two-wire audio repeater which gives a high-grade circuit over 25 miles of field cable.

A lightweight page teleprinter was shown which weighs 47 lb with its dust and immersion-proof covers as opposed to 190 lb for the present Army teleprinter and case. It is capable of operating at a speed 50 per cent greater than the present Army teleprinter (i.e., 75 bauds).

A proportion of the effort of this Group is also devoted to research, and one item is an attempt to synthesise speech from a small number of slowly varying parameters in order to achieve a significant reduction in the bandwidth involved.

Electro-Acoustics Group.—The Electro-Acoustics Group investigates the special acoustic problems associated with Army communications. An exhaustive study is being made of speech communication in high ambient noise, work being carried out both in the field on armoured fighting vehicles and at S.R.D.E. under controlled laboratory conditions. Facilities have been provided for establishing in the laboratory the high sound levels experienced in A.F.V.s and for conducting speaking and listening tests with or without superimposed electrical interference.

In the interests of standardisation, S.R.D.E. have recently sponsored the development of a standard electromagnetic microphone inset, a standard carbon microphone inset and a standard telephone receiver inset.

Other work includes the development of loudspeaking equipment and loudhailers. Considerable effort in the Group has been devoted to a study of recording media, and attention is now centred on magnetic tape recording.

Radio Group.—The Group is occupied at the present time with the development of a new range of signals and regimental wireless sets. The signals equipment consists of multi-channel micro-wave and v.h.f. sets to be used by the Royal Corps of Signals in rear and intermediate areas.

The regimental sets are used in forward areas by the fighting regiments and divide into four categories: the company to platoon infantry man-pack set; the battalion to company infantry man-pack set; the vehicular set for short or medium ranges; the vehicular set for longer ranges.

With the exception of sets in the latter category which are amplitude modulated and work on h.f., all others operate in the v.hf. band and employ frequency modulation. The complexity of the sets has increased, but special precautions have been taken to ensure that maintenance by R.E.M.E. is not unduly complicated.

A typical tank installation consists of a main wireless set which provides communication within the squadron, a subsidiary set providing communication within the troop and a third set for tank-infantry communication. These sets are interconnected by means of a multi-wire harness and intercommunication telephone which provide the necessary facilities for the various members of the crew.

The new range of sets are hermetically sealed and are therefore capable of withstanding extreme climatic conditions in all parts of the world. Another important characteristic is the "no-netting" facility. In the past it was necessary for the receiver to be tuned to the distant transmitter in order to establish communication. This involved a "netting" drill that was cumbersome and required the "control" transmitter to radiate during the "netting" procedure. After much investigation into various possible methods, each of differing complexity and merit, the present system was decided upon, and so far seems to meet very adequately the Army requirement. The set is free tuned and contains a crystal calibrator to which the local oscillator is aligned. The r.f. and oscillator circuits have been made sufficiently stable to render it unnecessary to recheck the tuning very frequently. Each set can be put correctly on frequency without reference to any other wireless set in the "net."

Engineering Division

The Vehicle Fitting Group of this Division is responsible for the waterproofing of vehicles and equipment for the purpose of wading operations and the wading demonstrations included the actual operation of a wireless set during a "wade."

The Mechanical Design Group has been largely concerned with the improvement of aerial masts, and a 100ft mast has been developed for which a vertical erection method, instead of the old horizontal system, can be used. Among the exhibits of the Pan-Climatic Packaging Group were a number of the materials employed, such as protective plastic coatings, metal foil coverings, and various cushioning agents. It is responsible also for the drop testing of components and assembled equipment.

Technical Services Division

Components Development Group.—Important factors, such as the stability and physical size of electronic equipment, depend to a large degree on the properties and dimensions of the components employed. The present trends in equipment design toward miniaturisation, tropic-proofing and general improvement in performance would not be possible without the greatly improved components which are being developed.

A considerable reduction in size of most components has been achieved since the war, and this was clearly shown in the case of electromagnetic relays, which were displayed. Improvement in tropical performance has resulted from the application of sealing or canning techniques, in certain cases. The latter technique is applied mainly to dynamic components, such as relays and vibrators, but for static components—such as coils and capacitors—potting or impregnation with suitable compounds has proved to be a good solution to the problem. Resins of the polyester and epoxide groups are currently being investigated for this purpose.

In radio communication, various factors, such as the increasing number of communication channels required and the impracticability in some cases of quartz crystal control, have made the development of stable oscillator and tuned circuits a matter of urgency. The main cause of frequency drift in oscillator circuits is the variation in capacitance and inductance of the circuit elements with temperature, and in view of the wide temperature range (−40 deg. to +55 deg. Cent.), over which Service equipment now has to operate, this problem has become acute. The frequency stability required can be stated to be of the order of ±15 parts per million deg. Cent., and to make such measurements, apparatus has been developed that is capable of measuring to an accuracy of approximately 2 parts per million deg. Cent. Other facilities for investigational purposes include powerful microscopes, X-ray equipment, a spectrograph and chemical apparatus.

Climatic and Durability Testing Group.—S.R.D.E. is fully equipped with all the apparatus required to carry out tests. For climatic tests, chambers are available for temperatures from −60 deg. to +70 deg. Cent., damp heat to simulate tropical conditions, low-pressure to simulate aircraft flying at altitudes up to 60,000ft, combined with low temperatures if required, and artificial rain and dust storms. For durability tests a bumping machine to simulate transport in a vehicle travelling over rough ground, various vibration machines and a drop test for packages are available. The vibration test consists of subjecting the equipment to vibration at all frequencies from 10 to 150 c/s.

Research Division

One of the groups which may be mentioned in the Research Division is that concerned with telemetry, and in the demonstration model shown, up to twenty-three quantities are electrically sampled and transmitted by radio to a receiver. The received signals are displayed on a cathode-ray tube, but they can also be recorded on paper. Any one quantity may change as many times as forty per second.

Daylight Signalling Lantern.—The Ministry of Transport states that the specification for a daylight signalling lantern to be carried by merchant ships, which was announced in April, 1950, has now been revised slightly with the object of greater clarity, and it has been decided to make the revised specification effective on November 19th next. On that date, lanterns required for replacement and for supply to new ships must conform to the revised specification. Lanterns manufactured to an earlier specification issued in October, 1948, which are covered by a Certificate of Approval from the Ministry, however, may continue to be supplied to British ships up to April 1, 1953, and may remain in use so long as they give efficient service. Copies of the new specification can be obtained from the Ministry of Transport, Berkeley Square House, London, W.1.

Two Machine Tools

WE have received from Kitchen and Wade, Ltd., of Arundel Street, Halifax, particulars of two new machine tools, recently added to its range of products. The first of these machines, illustrated alongside, is a horizontal drilling, boring and tapping machine, with a 2in diameter spindle, having the nose end bored No. 5 Morse taper. This spindle is supported throughout its 24in traverse by a large-diameter steel sleeve, on which the feed rack is cut.

Both fine and rapid hand adjustments are provided to the spindle, the former by the small handwheel at the side and the latter by the cross handles. Once the desired position has been reached a slight forward push on the handles engages the power feed. The cross handles can also be used for sensitive lever feed when drilling small holes.

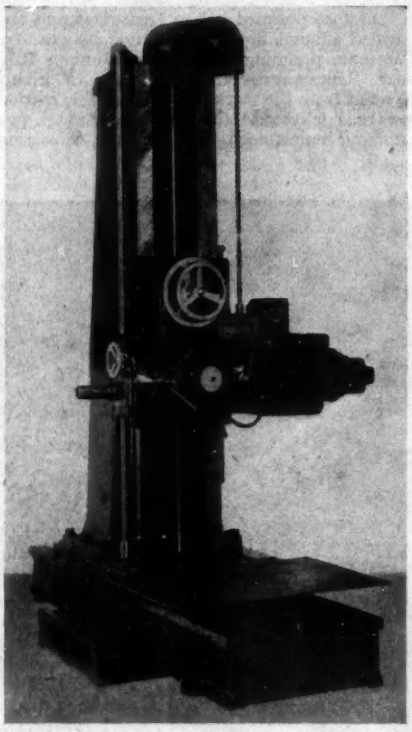
A 5 h.p. motor is built into the saddle and twelve changes of spindle speed, in one of four series from 1500 r.p.m. to 45 r.p.m. down to 600 r.p.m. to 18 r.p.m., are available. All the speed changes are obtained by a single lever, the speeds selected being directly indicated. A master electric control provides forward, stop, inch, and reverse movements to the spindle, and a quick-reading dial on the front of the saddle gives speeds and feeds to be used in various metals within the capacity of the machine.

The column has 5ft of traverse and moves on four enclosed ball-bearing rollers on the bed slideways, the saddle being balanced by weights housed inside the column. The locking and traverse motions for both column and saddle are operated from the saddle, which has 4ft of movement vertically. We are informed by the makers that the machine can be equipped with one of a wide range of work tables.

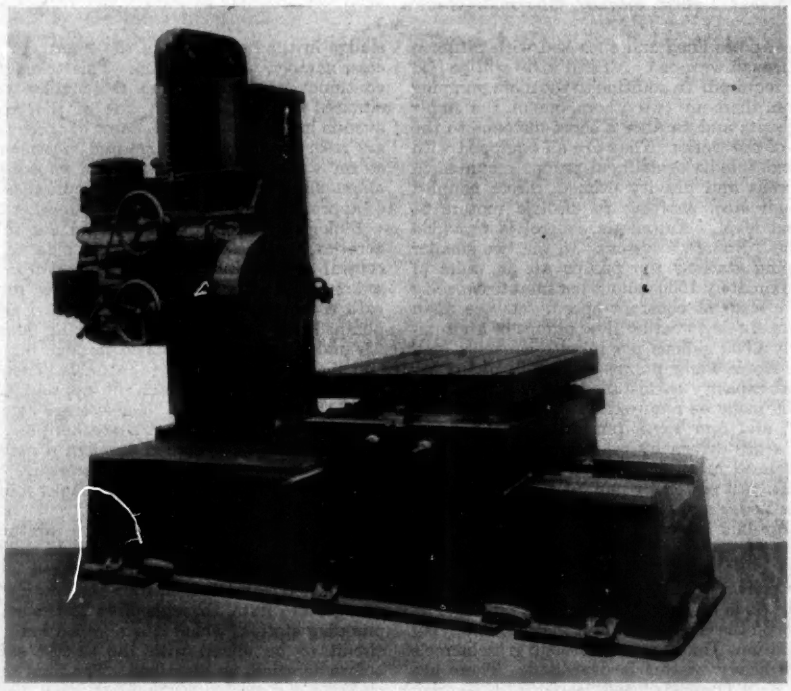
The second machine is particularly designed for the facing of cast iron and steel pipe flanges up to 30in diameter, and, as can be seen from the photograph reproduced below, is of robust, simple construction. In this machine all the running mechanism is enclosed in the head, which also carries the main 5 h.p. motor, which provides two speeds to the 24in diameter facing head. Two facing head speeds in two series are available: 30 r.p.m. and 50 r.p.m., and 15 r.p.m. and 25 r.p.m.

The facing head is mounted on a large-diameter spindle, and carries the facing slide, which is fed by a power-operated enclosed screw. It is provided with taper jib for taking up wear and two tee slots to allow alternative positions for the tool holder for facing large or small pipes or for facing inwards or outwards from the facing head centre. The tool holder takes 1¼in square shank tools. A choice of two facing slide feed rates is available at $\frac{1}{32}$in or $\frac{1}{24}$in per revolution, and the facing slide length of feed is 9in.

A compound table fitted on the machine is adjustable through quick-pitch screws, and it has a 3ft square working surface. A jacking device incorporated in the table assembly can be used to break the joint so that the table can be rotated freely on ball bearings.



DRILLING BORING AND TAPPING MACHINE



FLANGE FACING MACHINE

Vishakhapatanam Shipyard

The Vishakhapatanam shipbuilding yard of the Scindia Steam Navigation Company is the only one in India which can build ocean-going ships. The company spent up to June, 1950, about Rs. 4.34 crores on the construction of the yard. It has constructed altogether eight ships, the last of which was launched in December, 1949. However, as the company could not raise enough funds to the extent of Rs. 8 to 10 crores required for developing the yard, it approached the Government with the proposal that the latter should take over the undertaking with all its commitments at the cost which the company had actually incurred for the purpose. Under the accepted industrial policy, shipbuilding is one of those industries which are the exclusive responsibility of the State except where the State itself finds it necessary to secure the co-operation of private enterprise; but the existing undertakings are to be allowed to develop for a period of ten years, during which they will be given all facilities for efficient working and reasonable expansion. In the light of the above policy and in view of the inability of the company to run the yard, the Government agreed in principle in January, 1949, to acquire the yard on the basis of valuation by naval experts. A French firm of naval engineers, la Société Anonyme des Ateliers et Chantiers de la Loire of Paris was accordingly appointed as valuation experts.

Early in 1950 the Government decided not to take over the yard immediately, but in order to keep it going placed an order for three cargo ships of 8000 tons each at a total cost of Rs. 1.94 crores. These ships have been completed and two of them have been sold, while tenders for the sale of the third have been called for. A further order for three more ships has also been placed and they are expected to be ready by the end of this year. A loan of Rs. 10 lakhs was given to the company for the construction of a third berth in the yard. The whole question was then reconsidered and it was decided to take over the yard for which a private limited company, viz., Hindusthan Shipyard Company, was floated on January 21, 1952. The new company, in which the Government hold a controlling two-thirds interest, took over the yard on March 1st this year. Negotiations were then started with the above-mentioned French company for technical assistance in the development of the yard and were concluded last month when an agreement was signed in New Delhi.

Under this agreement, which comes into force from July 15, 1952, for a period of five years, the French firm will provide technical advice in regard to the organisation, development and management of the shipyard at Vishakhapatanam and the building of ships, vessels, naval crafts, engines and all forms of ship equipment. It will also help in establishing a fully equipped and competent designing and estimating office, will train and guide the Indian staff "so as to fit them for positions of the highest responsibility," will endeavour to secure orders from outside India and, if necessary, with the approval of the Indian firm, bring about the sale of ships constructed at the yard.

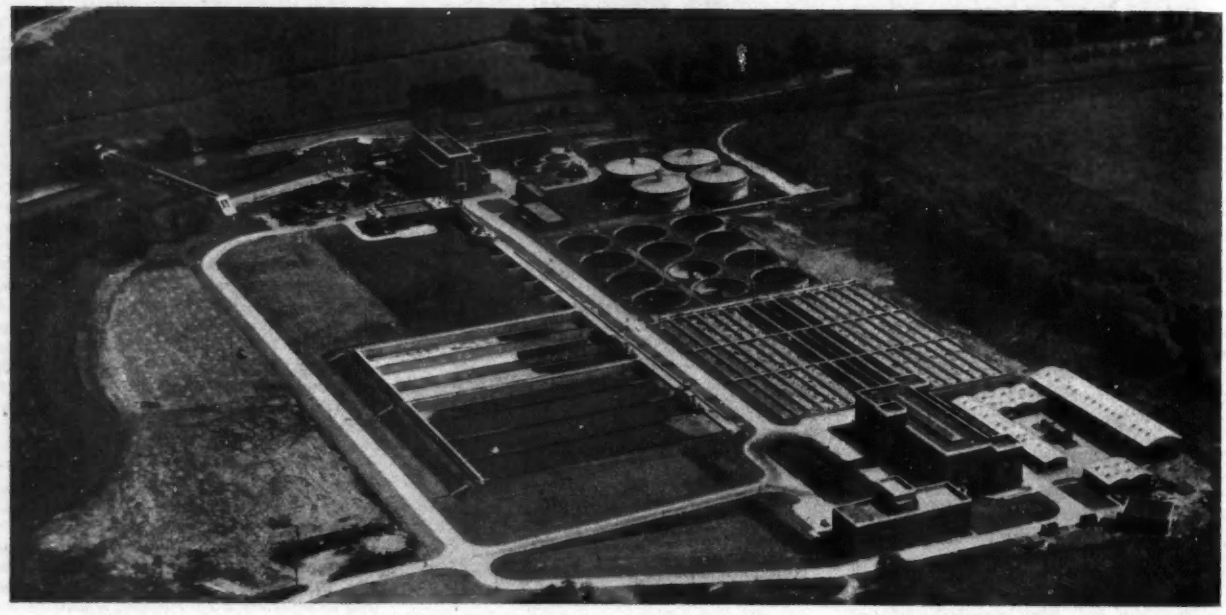
FLUORINE IN WATER SUPPLIES.—A belief that the intake of fluorine into public water supplies, in areas where there is insufficient, would help to reduce dental decay, is expressed by Lieut.-Colonel E. F. W. Mackenzie, the director of water examination of the Metropolitan Water Board, in a paper published by the British Waterworks Association, called "The Prevention of Dental Caries by the Administration of Fluorine in Public Water Supplies." The method described is, according to Colonel Mackenzie, "simple and inexpensive."

Opening of the Maple Lodge Sewage Disposal Works

ON Saturday last, July 12th, the Maple Lodge sewage disposal works of the Colne Valley Sewerage Board were officially opened by the Lord Lieutenant of Hertfordshire. Maple Lodge works will treat the sewage from an area of some 144 square miles, in which the cities of St. Albans and Watford are situated, and including roughly Bushey, Elstree, the Rowley Ward of Barnet U.D.C., Potters Bar, North Mimms, Sandridge, Redbourn, Hemel Hempstead, and Chorley Wood. It is intended eventually to serve a population of well over half a million, the sewage being treated by the activated sludge system and purified so that the biological oxygen demand of the effluent and the suspended solids will not exceed two and three parts per 100,000 respectively. The scheme has already been described in these columns; on October 31st, 1947, an account of the progress at that time was given, with some details of the power-house, pumping station and treatment equipment; some further progress notes were given in our issue of January 6, 1950, and the details of the comminutor plant and the sludge filtering and drying plant were described in our issue of January 25th last. As the scheme is an important one, however, a brief overall account of it is given herewith.

The Colne Valley scheme is essentially a system of trunk sewers designed to link up the sewerage systems of the communities to be served into a single system, with a central works at which the sewage from the whole area is treated. The total length of the trunk sewers is about 55 miles, the greater part being constructed of spun concrete, spun iron, or steel pipes of circular section varying in diameter from 15in to 75in, laid in open trench and surrounded in concrete. A total of about 6 miles of sewers has been constructed in tunnel, often requiring the use of a shield and compressed air. In the comparatively short tunnel section constructed before the war, cast iron segments were used, lined with concrete applied by the "gunite" process, screeded to a smooth finish. After the war the price of cast iron increased so much that the use of precast concrete segments was adopted.

The site chosen for the treatment works, like most land in the river valleys of the district, is liable to flood, and the subsoil consists of alluvial gravel, with some surface peat waterlogged nearly to the surface, and overlying chalk. The construction of large tanks in such ground is very difficult and costly, and for this reason, and to avoid the danger of flooding, the works at Maple Lodge were constructed largely above ground, the sewage level in the various tanks and channels being about 10ft above the original ground level. All sewage is therefore pumped before treatment and the purified effluent flows to the river by gravity. The main pumping station is at Juniper Hill, near Rickmansworth, a distance of about 1½ miles from the works site. From this station sewage is delivered to Maple Lodge through two pumping mains, each 48in diameter, consisting of steel pipes lined and sheathed with bitumen and hessian wrapped. A third main will be laid when required. In addition to the main pumping station, there are two others, one on the Maple Lodge site and another a short distance to the west of the works. They are all equipped with vertical spindle centrifugal pumps mounted in dry wells and gravity primed, direct coupled through steel shafting to electric motors at ground level. Automatic control is provided by the "Noflote" system. In the two smaller pumping stations the pumps are in units of approximately 1000 gallons per minute capacity and operate at constant speed. At the main station six dry weather flow pumps of approximately 4000 gallons per minute capacity, and three storm water pumps of 10,000 gallons per minute capacity are installed now, and additions can be made as required up to a total of nine d.w.f. and four s.w.f. pumps. All the d.w.f. pumps are driven by two-speed motors. The static head in all cases is of the order of 20ft to 25ft. All power for pumping is generated at Maple Lodge and transmitted to the stations by underground cables.



THE MAPLE LODGE SEWAGE DISPOSAL WORKS

Sewage Treatment

Sewage arrives at the works from the pumping main, which crosses the Colne on a pipe bridge, shown on the left-hand side of the accompanying illustration. It first passes through grit channels where heavy matter is deposited. There are four such channels, each capable of passing about 22 m.g.d. At the outlet of each channel a standing-wave flume has been provided, which not only measures continuously the flow of sewage, but also, in conjunction with the special shape of the channel cross section, controls the velocity of flow to the rate at which the heavier solids will settle out. The settled grit is removed, washed and pumped to the lake adjoining the works site.

After leaving the grit channels, the sewage passes the storm overflow weir (where flows in excess of three times the dry weather flow are diverted to a culvert leading to the storm water settlement tanks) and then flows through a measuring flume to the comminutors. These machines disintegrate all solid matter without removal from the sewage flow. Control of the grit channels and comminutors is automatic. As the rate of flow increases an additional grit channel and, if necessary another comminutor, is brought into operation. The motorised control penstocks and the comminutor motors are controlled by the sewage level above the measuring flume. As the flow decreases the level falls and the reverse action occurs.

Most of the solid matter is settled out as sludge in the next stage of the treatment process, namely, sedimentation. This takes place continuously in the large rectangular tanks situated on the left-hand side of the central avenue in the illustration. Some of these tanks are reserved for the storage and treatment of storm water. Each tank has a capacity of about 900,000 gallons, with a retention period of approximately 7½ hours at dry weather flow.

Biological purification is carried out in the aeration channels on the other side of the central avenue, into which the liquid from the sedimentation tanks is conveyed after mixing with a measured quantity of activated sludge pumped from the central pumping station. Air under pressure is supplied through diffusers laid along the bottom of the channels. There are eight aeration units, each of approximately 750,000 gallons capacity. The average aeration period is twelve hours at dry weather flow. Air for the process is supplied through a network of pipes from three turbo-compressors, each having a capacity of 6500 cubic feet per minute, installed in the power-house.

From the aeration channels the mixture of sewage and activated sludge passes to the final settlement tanks, where the activated sludge is separated by settlement from the now purified sewage, and flows through pipes to the central pumping station, where it is pumped back into circuit to be mixed with the settled sewage before aeration, as described. The final settlement tanks, twelve in number, each have a capacity of 250,000 gallons, and from them the

purified sewage flows to the effluent channel and thence to the River Colne.

Sludge settled out in the sedimentation tanks is removed daily by mechanical scrapers and flows through pipes to the central pumping station, whence it is pumped to the digestion tanks. The sludge gas is collected in the gas-holders and piped to the power-house, where it is used to operate the power units as an alternative to fuel oil. The sludge in the tanks is kept at the optimum temperature for digestion, about 85 deg. Fah., by utilising waste heat from the power plant in the form of hot water, which is circulated through coils fixed to the inside walls of the tanks. The digestion process results in a reduction of about 40 per cent of the organic matter present in the sludge and leaves a residue which is free from objectionable odour.

The methods used for dewatering the digested sludge and also the surplus activated sludge, together with the method of sludge drying adopted, are of special interest. Sewage sludges are difficult to dewater mechanically, and before the solid particles can be separated from the containing liquid they have to be coagulated into larger masses. This may be achieved by "chemical conditioning"; before the digested sludge is so conditioned, it is passed through two elutriation tanks, where dissolved compounds resulting from the digestion process, and which would have a heavy chemical demand on the conditioning materials are washed out, the washing water used being purified sewage effluent.

The sludge drying plant is housed in the buildings shown in the background of the illustration and comprises vacuum filters and flash drying and incineration units. The vacuum filtration plant has six vacuum filters. Surplus activated sludge and elutriated digested sludge may be treated separately or may be mixed before treatment, as required. The process of vacuum filtration is essentially a continuous separation of most of the solid matter in the sludge from the liquid portion by suction, using a closely woven fabric, such as woollen cloth, as the filtering medium. By this process from 80 to 90 per cent of the water is removed from the sludge and any further drying requires the application of heat.

After filtration the sludge is carried on a belt conveyor to the flash drying plant, where, after mixing with previously dried sludge to produce a flakey mixture, it meets furnace gases at a temperature of about 1100 deg. Fah. The remaining moisture is instantly driven off and the gases convey the dried sludge, now in powder form, to a separating cyclone. The heat required is generated in furnaces burning pulverised coal or dried sludge, or a mixture of these two fuels. Thus the sludge itself, if burned, may be made to contribute much of the heat required to drive off the moisture remaining after mechanical dewatering. Alternatively, it may be extracted instead of being burned and used as a fertiliser. If sludge is not incinerated, the whole of the heat required will be provided from the combustion of coal, which is conveyed to the works by canal and mechanically unloaded at the Board's wharf adjoining the sludge disposal building. Four furnace units, each capable of handling about 4500 lb of sludge cake per hour, have been installed, and it is expected that these units, with the associated vacuum filtration plant, will be able to treat the sludge from the whole of the future population to be served by the Board's scheme.

At Maple Lodge all electric power required for sewage and sludge pumping, air compressing, sludge treatment and the many other mechanised processes, as well as for lighting, is generated in the power-house. Six power units have been installed, each comprising a "dual-fuel" diesel engine of about 700 h.p., capable of operating on sludge gas or on fuel oil, or a mixture of the two fuels.

A comparatively small area of land is required by the works. By combining mechanisation with a compact layout the works (including future extensions for which provision has been made) occupy only 26 acres, as compared with about 500 acres, which is the aggregate area of the local disposal works the Board's scheme replaces. A simple but effective scheme of landscaping has been prepared, which will harmonise with the predominantly rural surroundings of the works and give a pleasing appearance to the whole site. The consulting engineers for the project are Messrs. Sandford, Fawcett and Partners.

South Africa's Reserves of Raw Materials

(By our South African Correspondent)

A PAPER read recently before the Institute of British Foundrymen (South African Branch), by Dr. W. Bleloch, provides some interesting data relating to South African reserves of raw materials, with special reference to the foundry industry. The following is a brief précis of the main points of the paper.

The Union and Rhodesias are exceptionally well endowed with enormous reserves of coal, iron, chromium, manganese and copper. In spite of this fact, the territory which is now the Union, produces, after 300 years of European settlement, foundry goods weighing less than 2 per cent of the American output and less than 5 per cent of the British output, even though these enormous reserves of cheaply mineable raw materials lie at shallow depths or outcrops, situated in regions with exceptionally healthy climates. Compared with Britain and Germany the Union has incomparably more iron, chromium and manganese ores, and also practically unlimited coal resources.

There are two factors which account for this slow development, namely, the lack of adequate cooling water supplies and the comparative unavailability of skilled and unskilled labour. In the great industrial countries of Europe and America, water seldom presents a problem in iron production, but in the Union and, in fact, in Southern Africa as a whole, the availability of cooling water is a limiting factor equalled only by the difficulty presented by the slender supply of suitable unskilled labour and the still more slender resources of skilled labour.

Coal Resources.—A rough allocation of coal reserves is set down as follows:

	Million tons
Transvaal	66,000
Natal	10,000
Orange Free State	150,000

Of coking coal there are possibly reserves of the order of 100 million tons, and possibly somewhat more. In the light of present knowledge much of this lies in the Natal field, with less in the Transvaal, and still less, or possibly none, in the Orange Free State. In these reserves are included only those coals which will give a reasonably good metallurgical coke, or a coke approaching metallurgical quality, or those coals which will give a coke of reasonably good quality when blended with coals which are either feebly coking or non-coking.

Of the so-called semi-coking or feebly coking coals, including non-coking coals which will give a good coke when blended with coking coals proper, there are reserves which have not as yet been accurately or even approximately computed. It would appear that there are possibly two to three times the reserves of these blend coals which are not in themselves coking coals, but can be used for the making of reasonably good, or at least, usable metallurgical coke. All of these coals are unfortunately high in ash content when compared with the coking coals of Europe and America.

The remainder of the coal resources, apart from coking and potentially coking coals, amounting to 99·95 per cent or more, is mainly bituminous coal varying in ash content from about 10 to 18 per cent or more, and having a calorific value of the order of 8500 to 12,800 B.Th.U. per pound or higher.

Iron Ore Reserves.—The Union has very large reserves of hæmatite iron ore. If the iron content is specified at not less than 35 per cent the mineable reserves of hæmatite ore in the Transvaal, Natal and Cape Province, in all probability exceed 200,000 million tons to a vertical depth of 2000ft. If, on the other hand, the iron content is fixed at not less than 52 per cent, then the probable reserves to the same depth of mining are of the order of 10,000 million tons. Thus the relation of the richer hæmatites to the total hæmatite reserves is similar to the relation between the available coking coal and the total coal reserves. The present South African pig iron output, involving a total capital commitment, including steel, of some £40 to £50 million, rests solely upon the relatively small fraction of coking coal in the total coal reserves and almost entirely on the relatively small fraction of rich hæmatite in the total hæmatite reserves.

The enormous reserves of low-grade siliceous hæmatites occur in beds which attain thicknesses in places greater than 45ft, and the length of strike of their outcrops is measured in thousands of miles. Extremely large tonnages are manganiferous to the extent of some 5 to 10 per cent manganese, but may contain as much as 25 to 30 per cent of that metal. They are, on the whole, readily accessible and near to such reserves of water as there are.

Of the titaniferous magnetites, the reserves of iron existing in them are very great and it may not be an exaggeration to say that in these magnetites exists incomparably the largest reserve of vanadium, more than 10 million tons at present known. Their potential value is such that there can be little doubt that they will be worked in the future by electric smelting for recovery of iron and vanadium.

Reserves of Chromium.—Associated with the titaniferous magnetites mentioned above there is a series of chromite seams. The magnetites and the chromite seams must have a similar origin as they both occur as relatively thin sheet-like bodies dipping at low angles of 20 to 30 deg. towards the centre of the associated Bushveld norite. The average thickness of the magnetites could reasonably be taken as 3ft to 4ft, whereas the chromium seams vary from a matter of inches to 3ft or 4ft. They show extraordinary persistence along the strike and in depth. Many of the seams are scores of miles in length of strike and are known to extend thousands of feet in depth.

To a vertical depth of 2000ft it is likely that the norite contains over 500 million tons of chromium metal in grades of chromite having a chromium content varying from 17 up to 31 per cent, or even a little higher. In general the chromites have a chromium/iron ratio of the order of 1·5 up to 1·8 to 1. The ore mineral is a chrome picotite in which some of the ferrous oxide is replaced by magnesia and some of the chromic oxide by alumina. The alumina content is on the average about 12 to 15 per cent and the ore cannot be used at present for any extensive manufacture of ferro-chromium on account of its high iron content. It can be used for ferro-alloy manufacture in admixture with Rhodesian ores of a chromium/iron ratio of 3 to 1, and is at present being used for this purpose. If an economic process could be developed for changing the chromium/iron ratio of the norite chromium ores, ferro-chromium could in all probability be made in the Union.

Manganese Ores.—There is only one region where accumulation of manganese in high-grade ore has proceeded on a grand scale. This is the well-known Postmasburg deposit. Of the western and eastern belts of this strike the former is a bedded deposit of fair persistence along the strike, but more than one horizon of ore is often present. The ores of the eastern belt are not well bedded and they exist more often as irregular disconnected bodies scattered throughout a siliceous matrix. One of the largest ore bodies located yielded a total weight of some 20,000 tons.

On the results of exploitation during the past twenty years it can be said that a reasonably sure estimate of the high-grade ores existing at present would be of the order of 20 to 30

million tons, with a much larger reserve of low-grade ore, probably exceeding 100 million tons. The bulk of this low-grade ore would in all probability be classed at present as manganiferous iron ores.

In addition there is a potential reserve of manganese in the Archæan rocks of the Pongola system and other ancient systems in the Eastern Transvaal, Northern Natal and Swaziland. The manganese bearer in these formations is generally a siliceous hæmatite iron ore which, as noted in the section dealing with iron ores, contains generally some 5 to 10 per cent of manganese, but may have as much as 30 per cent. Manganese cannot at present be recovered economically from the ores in this country, but there is little doubt that ultimately they will be the source of large tonnages of manganese, when the ores are smelted for recovery of iron. The manganese can readily be recovered in a concentrated form with little iron present as steel converter slags. Much development in this process of recovering manganese from low-grade ores by this process and by leaching methods is at present being done in the United States. As a first approximation it is computed that the reserves of manganese in these deposits, which extend to very great depths beneath the surface probably exceed 2000 million tons of manganese metal to a vertical depth of 2000ft, and they are therefore incomparably greater than the presently estimated reserves at Postmasburg.

Conclusions.—The present output of iron and ferro-alloys in South Africa is based almost entirely on the technology of Europe and America, which is indisputably the outgrowth of the very great reserves of cooling water and first-grade coking coals of these countries. It is obvious that lack of cooling water and coking coal and the comparatively low reserves of high-grade hæmatite will ultimately force South Africa to use its non-coking coals, siliceous hæmatites, low-grade chromite and low-grade manganese ores, for the production of iron and ferro-alloys by technologies differing widely from those of America and Europe. The materials are available and, given time and incentive, there can be little doubt of their ultimately successful use. Much work is already in course for recovery of high-grade ferro-alloys and iron-rich chromites.

It is considered that the technology of the process of production of iron and ferro-alloys by electric power is one which, while virtually undeveloped in the Union, possesses advantages which are apparently little realised. This may be seen from the following comparison between production by the blast-furnace and by electric power.

It is a well-known fact that to reduce hæmatite iron ore to pig iron requires on the average 0·8 to 1·2 tons of metallurgical coke. For the purpose of comparison it is assumed that a hæmatite containing 45 per cent of iron and 20 per cent silica with a low content of phosphorus is to be reduced in an electric furnace. To make 1 ton of pig iron containing 4 per cent of carbon and 1 to 2 per cent of silicon for steel-making by the duplex process, it is now a well-established fact that a pre-reduced sinter from such an ore requires about 2200kWh of power and about 0·45 ton of a low-grade anthracitic coal.

The following three power plants to meet the above requirements are compared: (1) a steam turbine plant in Europe or America using 12,500 B.Th.U. per pound of coal, costing 45s. per ton at an overall thermodynamic efficiency of 21 per cent, taking the price of cooling water at 2d. per 1000 gallons; (2) a steam turbine plant in South Africa using 10,500 B.Th.U. per pound of coal at 7·5s. per ton, with cooling water at 6d. per 1000 gallons and assuming 19 per cent overall efficiency; (3) an open-cycle, single-line gas turbine plant operating on producer gas of calorific value 110 B.Th.U. per cubic foot, made from coal costing 7·75s. per ton and assuming that the plant operates at an overall thermal efficiency of 21 per cent. According to the calculations made the cost of power in each case is, for (1) 0·565d. per kilowatt-hour; for (2) 0·237d. per kilowatt-hour, and for (3) 0·321d. per kilowatt-hour. The gas turbine plant operates with very much less water, using about one-tenth of that required by a steam plant of equal output.

After further comparisons relating to the relative merits of the blast-furnace and electric methods of pig iron and steel production, the author comes to the conclusion that if such methods as he indicates, using gas turbine plant, can succeed in producing steel and ferro-alloys economically from South African siliceous hæmatites and non-coking coals, there is virtually no limit to the country's potential output of iron, steel and ferro-alloys and foundry products, even though its coking coal and water reserves are relatively very small compared with those of Europe and America.

Diesel-Electric Locomotives for Australia

At the recent British Industries Fair a scale model of a 1000 h.p. diesel-electric switching and shunting locomotive was shown by the British Thomson-Houston Company, Ltd., which has on order for the New South Wales Government Railways ten locomotives of this design. As main contractors, B.T.H. is co-ordinating the overall design and manufacture of the locomotives, for which the company is supplying the main and auxiliary generators, motors and control equipment. The manufacture of the mechanical parts is being carried out by the Metropolitan-Cammell Carriage and Wagon Company, Ltd., and the diesel engines are being supplied by Davey, Paxman and Co., Ltd.

The locomotives are required for handling very heavy trains on shunting and switching duty and the design tractive effort is 48,000 lb at starting and 22,800 lb in continuous service. The maximum road speed will be 57 m.p.h., which will permit the hauling of light branch line trains at comparatively high speeds. In full running order, the approximate weight of these B_o-B_o locomotives is 72 tons.

In each locomotive the driver's cab is in the middle and the cab is fitted with duplicated control positions for use in either direction of running. Two engine-generator sets are installed and all the axles of the two four-wheel equalised bogies, with swing bolster, are motor driven. The axles are fitted with Skefco self-aligning roller bearings and the two bogies are interchangeable. At each end of the locomotive is a Serck radiator and Visco air filters are fitted for each engine and generator.

The Paxman "12 R.P.H.L. series 2" engines are rated at 500 b.h.p. at 1250 r.p.m. The two-valve Ricardo "Comet" combustion system is used and the engines are naturally aspirated.

The main generator, specially designed for the severe duties associated with diesel-electric traction work, is a single-bearing machine having a self-aligning roller bearing at the commutator end; the other end of the armature is solidly coupled to the engine crankshaft. A fabricated magnet frame carries supports for the auxiliary machines, which are belt-driven from an extension of the generator shaft. Insulation is Class B, consisting entirely of mica, glass and asbestos, finally treated with a high temperature insulating varnish.

The series wound traction motors are of the conventional box-frame construction and are axle mounted. The axles are driven through heat-treated steel gearing, the gear-wheel being of resilient construction, which permits a degree of torsional resilience between the gear-wheel centre and the toothed rim.

Based upon the use of the familiar three-winding generator, the control scheme is supplemented by a speed sensitive exciter, which is used to energise the separately excited field of the main generator. With this arrangement a very small drop in engine speed is sufficient to reduce the load to a point where engine power and generator output are balanced.

At each of the two driver's control positions in the cab there is a control unit comprising power controller, key-operated reverse drum and instrument panel. The reverser key is removable in the "off" position and it must be inserted in the control unit which is to be used to drive the locomotive.

An engine control panel in the cab contains the starting switches, meters and gauges associated with the two engines. Engine starting is by motoring the associated main generator, power being provided by a lead-acid battery. Interlocking prevents both engines being started at the same time, to avoid overloading of the battery.

Electric Valve Heaters

In many industries the heating of valves and pipe-lines carrying fluids or gases at elevated temperatures is an important matter. To meet this need, Isopad, Ltd., London, N.W.3, is now producing a range of electric heaters, and our illustration shows an "Isovalve" heater fitted to a 3in special valve. The valve heater has two separate circuits, connected in parallel, controlled by a switch mounted on the terminal box. One circuit can be switched on and this will be sufficient to maintain the valve at a temperature sufficient to prevent coagulation of the contents, while double loading can be applied by switching on both circuits for heating purposes after the plant has been shut down.

The heater consists of two halves hinged together so that it can be fitted easily and quickly on the valve, and the heaters are manufactured to suit all sizes of valves from the

"ISOVALVE" ELECTRIC HEATER

smallest to the large gate valves of 16in bore. The heating element follows the contours of the valve and adequate thermal lagging ensures high efficiency, while metal covers provide protection. The power loading is decided to suit individual requirements regarding the temperature of the contents; for example, a 3in valve heater providing a temperature rise of 50 deg. Cent. has a 50W loading, and a heater for a 5in gate valve providing for a 130 deg. Cent. temperature rise will require 300W. Within the range of heaters produced by the company, 400 deg. Cent. (750 deg. Fah.) can be compensated for; and energy regulators give exact control over the heat input while, where a number of heaters are used for one installation, central control for all the heaters can be provided.

Research in the Electrical Manufacturing Industry*

By K. J. R. WILKINSON, D.Sc., M.I.E.E.

No. II—(*Concluded from page 65, July 11th*)

The Dielectric State of Transformer Major Insulation.—It is usual practice in high-voltage power networks to employ a star-connected bank of three single-phase potential transformers, the three having a common earthed neutral. In each of these units the major h.v. dielectric (the insulation to ground, as distinct from the insulation between coil sections) sustains a 50-cycle displacement or charging current with a loss angle which is a measure of the state of the major insulation. In order to determine the value of this loss angle under working conditions, research within the electrical manufacturing industry has developed the form of a.c. bridge circuit shown in Fig. 2. In this circuit, which is adapted for use both in the factory and on site, the h.v. is disconnected, and in order to eliminate bushing currents from the measurement by a guard ring, the lid of the transformer is electrically isolated (with its holding-down bolts removed, the gasket affords adequate isolation). This example of a measuring technique serves very well to indicate the flexible outlook which is so necessary in research of this type. It combines respect for the fundamental requirements of the a.c. bridge, which is to measure the small dielectric loss angle, with dexterity in coping with the two conditions that make this measurement awkward; these are that voltage distribution within the transformer shall remain normal and that the unwanted capacitance currents in the h.v. bushing shall be excluded from the measurement.

High-Impulse Voltages.—The measurement of impulse waveforms at very high voltages often makes use of a resistance potential divider. This is practicable where an impulse generator tail resistance, for example, can be used in this

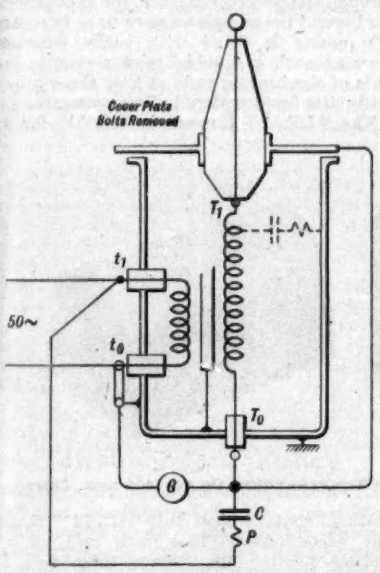


FIG. 2—*Measurement of Major Dielectric State in H.V. Potential Transformer*

way, but sometimes resistance dividers are not convenient. In a recent development a capacitance has been designed for use at up to 2MV. Here, the electric field is in air and the electrodes are two structures shaped rather like buns with their flattened portions facing and parallel, so as to give a substantially uniform electric field near the axis.

The electrodes and the impulse generator to which they are connected were designed in a research laboratory for use in a factory, where Fig. 3 shows the complete system installed. The lower of the bun-shaped electrodes is part of the roof of a room which contains the oscillo-

* Abstracts. Paper presented on behalf of the British Electrical and Allied Manufacturers Association, at the British Electrical Power Convention, Bournemouth, June 17, 1952.

graph equipment and this lower electrode can be raised at will so as to shorten the gap. The electrodes are 10ft in diameter and in the central part of the lower one there is a trepanned disc, 30in in diameter, which affords the working surface and is connected to the l.v. condensers and oscillograph. Because the equipment occupies valuable factory floor space it was necessary that it should be installed as close as possible to an end wall. Therefore before the electrodes were designed tests were made, using an electrolytic bath to establish the shape of the electrodes necessary to meet certain clearance distances to the wall; the present clearance is 8ft. Other bath tests determined the effectiveness of the three-

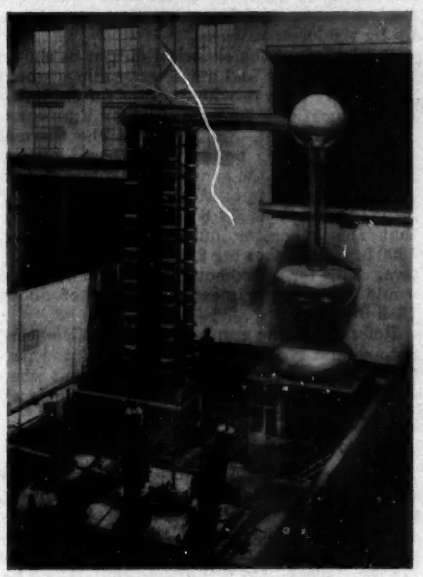


FIG. 3—*2MV Impulse Generator and Voltage Divider*

electrode high-voltage capacitance against stray external electric fields. The equipment has only recently been completed and is not yet fully commissioned.

Development

Silicones and Polyester Resins.—Kipping's classical work at Nottingham introduced a new and wide range of organic compounds, but did not suggest, even to him, that some of the results would achieve industrial importance. It was the search for an insulating varnish of increased thermal stability which led the electrical industry not only to the required varnish, but to silicone oils, greases, rubbers, paints and water repellents. Organic insulations are generally unsuitable for continuous use at temperatures above 130 deg. Cent., but organic compounds in which some of the carbon is substituted by silicon show a much greater ability to withstand high temperatures. As a result of research in the preparation and application of these silicone insulations it is now possible to provide electrical insulation which is serviceable at 180 deg. Cent. Thus machines can be operated either in higher ambient temperatures or made smaller and lighter than was previously possible.

The polyester resins have a different history; they have been used principally in structural applications lying quite outside the electrical field, but in specially modified forms they are likely to find an increasing use in electrical equipment. Since the quantities required for insulation may be much smaller than those used, for example, in the hulls of boats, it is perhaps appropriate that the research which is necessary to adapt these resins to electrical use should be carried out within the electrical industry itself. Such research is now taking place and considerable progress has already been made.

The polyester resins are mobile liquids, which can be set to infusible solids either by heat or, at room temperature, by the addition of accelerators. The resins can be prepared so as to exhibit in the cured state any one of a number of degrees of flexibility, or other physical or electrical property. Their importance is that they contain no solvent and give off no volatile matter when they cure, so it is natural that research should also be concerned with the possible applications of these resins. They are admirable, for example, as solventless varnishes and as casting resins, and give particularly strong laminates with woven glass cloth. They can also be used very successfully for bonding mica.

Some examples of more specific applications include the impregnation of aircraft magneto coils to exclude moisture and eliminate corona at higher altitudes and the impregnation of contactor coils to improve their thermal dissipation. They have also been used not only to impregnate the slot portion of motor windings, but—in the same operation—to build up a protective casting around the end windings; this serves both to reduce thermal impedances in the machine and to protect the windings against moisture and other damage.

Pulsactor Switches.—It is difficult, except for those intimately concerned with such research, to appreciate the capabilities of the non-linear properties of ferro-magnetic material. A great impetus was given to this work by the development of radar, and by the corresponding search for a reliable switch in the radar modulator. The task of such a switch is to close and thereby pass a current of perhaps 100A lasting for a microsecond or so. The current remains constant during this time because it flows into what is effectively a resistance and is derived from a pulse-shaping network or cable; so before it closes the switch must be able to withstand some tens of kilovolts—the voltage to which the cable is charged. The purpose of this is to apply energy in short pulses to the magnetron.

Hard valves, thyratrons and spark gaps have

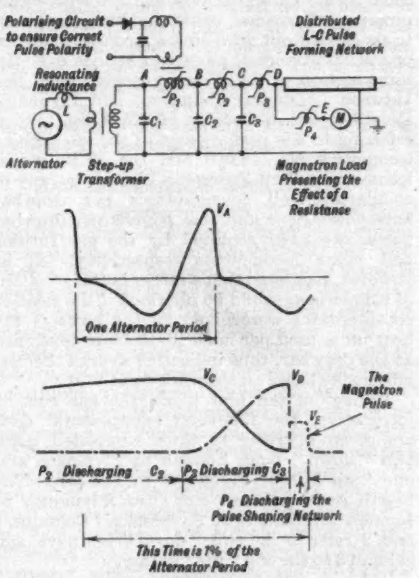


FIG. 4—*Saturable Reactors in Cascade Forming a Modulator Switch*

all been used as modulator switches in radar, but a most interesting technique recently developed* uses none of these. In this, the function of the switch is performed entirely by the change in inductance of a reactor having a highly rectangular *B-H* loop. There are, of course, limits to the product of voltage and time which can be withstood by such a reactor when in its "non-conducting" or high inductance state—if the same reactor is to present a specified low inductance in the saturated or "conducting" state. These natural limits decide just how long such a reactor can withstand a given voltage before it begins to "conduct," and they have been overcome by the elegant device of design-

* W. S. Melville, *Proc. I.E.E.*, Part III, Vol. 98, May, 1951, page 185.

ing such reactors to be used in cascade. The method is shown in Fig. 4, where four saturable reactors P_1, P_2, P_3 and P_4 successively discharge four condensers (C_1, C_2, C_3 and the pulse-forming network) in times which become shorter in geometrical progression. An alternator, generating a sinusoidal waveform, and tuned to resonate with its effective load circuit (C_1, L) produces at C_1 (which is recurrently discharged when at maximum voltage by the chain of saturable "switches") the waveform V_A. When this voltage reaches its maximum value it is suddenly transferred to C_2 through the action of P_1, and by a similar though later and still faster action from C_2 through P_2 to C_3 and so on. The later stages of this sequence are drawn as V_C, V_D and finally V_E—the rectangular voltage form generated by the pulse-shaping network and applied to the magnetron.

Performance of the Western Region Gas Turbine Locomotive No. 18,000

By E. C. POULTNEY, O.B.E., M.Inst.Loco.E.

IN THE ENGINEER of May 16th, very complete particulars were given of a series of trials carried out with the Western Region British Railways gas turbine locomotive No. 18,000, the first of this kind of power to operate on the railways of this country, and later, in the issue of May 30th, a leading article discussed in an informative manner the performance of this notable engine as disclosed by the test results, and referred at the same time to the working of steam locomotives operating under similar conditions.

The purpose of the present article is to carry the discussion initiated by THE ENGINEER a step further by considering the working results obtained with the gas turbine locomotive from the thermodynamic standpoint; and, at the same time, to attempt a comparison with steam power performance based on the results of trials carried out with steam locomotives when operating in normal passenger service over the same section of the Western Region main line between London (Paddington) and Plymouth (North Road), a distance of 225 miles. When referring to the performance of the gas turbine locomotive No. 18,000 and the W.R. steam locomotives, THE ENGINEER quoted, by way of comparison, oil consumptions per drawbar horsepower-hour and coal pounds per drawbar horsepower-hour required by the gas turbine and steam locomotives respectively. It is, however, suggested that a rather better standard of comparison would be obtained if the relative consumptions were given on the basis of the heat units used per horsepower-hour developed at the drawbar, thus indicating overall thermal efficiencies based on the work done.

Taking, in the first place, the gas turbine locomotive, the following experimental data are given referring to three completed trips, two "down" from London to Plymouth and one "up" from Plymouth to London. The fourth and final test run from Plymouth to London terminated at Savernake. Columns 1 and 2 refer to the two "down" journeys, and column 3 to the one "up" journey:

Gas Turbine Performance

	1	2	3
Distance, actual miles ...	225·2	225·2	225·2
Time, running minutes ...	252·3	251·4	269·0
Average speed, miles per hour	53·6	53·7	50·2
Average drawbar pull, tons	2·25	2·59	2·46
Average drawbar horsepower	721	831	736
Oil, pounds per drawbar horsepower-hour	2·05	1·93	2·17

Two different qualities of oil are used, a heavy oil and a light oil, and the original test data gives the total amounts of each oil used for each single journey and the respective gross calorific values.

From these particulars the heat values expressed by the B.Th.U. content in the oil used per drawbar horsepower are computed. These values are as follows:—

Journey, column 1:
- Oil per drawbar horsepower-hour ... ... 2·05 lb
- B.Th.U. per drawbar horsepower-hour 37,085
- Overall thermal efficiency, per cent ... ... 6·8

Journey, column 2:
- Oil per drawbar horsepower-hour ... ... 1·93 lb
- B.Th.U. per drawbar horsepower-hour ... 35,900
- Overall thermal efficiency, per cent ... ... 7·1

Journey, column 3:
- Oil per drawbar horsepower-hour ... ... 2·17 lb
- B.Th.U. per drawbar horsepower-hour ... 40,500
- Overall thermal efficiency, per cent ... ... 6·3

The thermal equivalent of 1 horsepower-hour is taken as being equal to 2545 B.Th.U.

These efficiencies being based on the horsepower developed at the drawbar between the locomotive and train, it would have been interesting to know the mean power output of the generator, thus indicating the power taken up by the locomotive.

Particulars of the electrical output as shown by the voltmeter and ammeter readings would presumably have provided means for obtaining this information. On page 667, THE ENGINEER, May 16th, a plot, Fig. 11, gives the thermal efficiencies of the power plant, based on the power output at the generator coupling and on the generator output. Assuming a mean power of 721 d.b.h.p. at 53·6 m.p.h., it is possible that the generator output might be, say, 1000 h.p., thus showing 279 h.p. for the locomotive. This for a locomotive weight of 119 tons would represent a mean resistance of about 16·5 lb per ton.

Referring to the graph of thermal efficiencies, note should be made of the fact that the performance shown relates to the power unit when using heavy oil only. At 1000 h.p., the efficiency is shown to be about 10 per cent.

COMPARISON WITH STEAM POWER

The gas turbine locomotive was originally built for the former Great Western Railway, presumably to operate express passenger services in competition with the standard four-cylinder simple expansion engines of the "King" class. On this assumption, therefore, it may be interesting to compare the performance of these two forms of motive power. For this purpose, reference can be made to the remarkably comprehensive locomotive trials carried out by the Railway Executive during 1948, from which the data tabulated below have been taken.*

The particulars given relate to the working of "King" class locomotive No. 6018, handling express passenger trains between London and Plymouth, being, therefore, in this respect comparable with the tests runs made with the gas turbine locomotive. The timings are, however, different; further, all the runs were subject to a number of signal and temporary permanent way checks, which would probably adversely affect coal consumptions.

Columns 1 and 2 cover two "down" trips from Paddington to Plymouth, and 3 and 4 cover "up" runs in the opposite direction. The mean powers shown have been computed from the test data, and the coal consumptions relative to the drawbar horsepower are based on running times.

Steam Engine Performance

	1	2	3	4
Distance, actual miles	225·1	225·1	225·8	225·8
Time, running minutes	282·4	288·9	287·8	282·6
Average drawbar pull, tons	2·5	2·2	2·18	2·12
Average drawbar horsepower	600	620	610	605
Coal, pounds per drawbar horsepower-hour	3·81	3·64	3·66	3·86
B.Th.U. per drawbar horsepower-hour	52,600	49,400	49,200	52,200
Overall thermal efficiency, per cent	4·84	5·16	5·17	4·87

* THE ENGINEER, July 15, 1949.

The heat values given for the coal are the values as received and, therefore, "as fired."

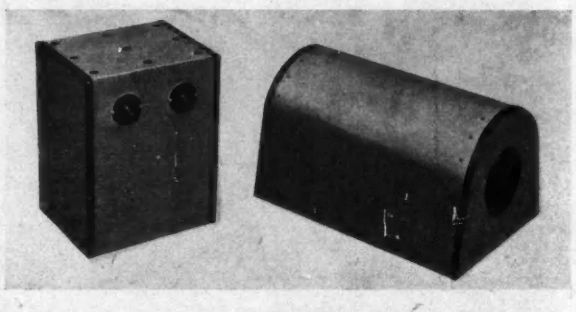
The overall thermal efficiencies given are relatively low when compared with those shown for the gas turbine locomotive. When considering these results, the circumstances ruling during the trials must be kept in mind for the reason that for uninterrupted runs a better performance could be reasonably expected.

High-Temperature Tube Furnaces

OUR illustration shows one of four high-temperature combustion tube furnaces which have been specially developed by Gradec, Ltd., 96, Hackney Road, London, E.2. This range of small-tube furnaces has been designed to exceed the maximum temperature of the normal wire-wound kind and to have a rapid heating up time. The normal maximum operating temperature is 1400 deg. Cent., but it may be used up to 1500 deg. Cent. occasionally at the cost of shortening the life of the heating rods. All these furnaces are designed to take a standard 1¼in O.D. combustion tube. They have the great advantage over gas-fired furnaces that there is no danger of contamination due to the by-products of combustion and the heating section is free from hot spots.

The furnace proper is cylindrical in shape and has a heating chamber 7in long and 3in diameter, which is made up of a fused alumina tube held in place by two refractory end pieces and insulated by a high-grade refractory insulating aggregate, so as to keep the heat losses down to a minimum. Provision is made for the silicon carbide heating rods to pass through the heating chamber, the ends protruding beyond the end pieces so as to be in cool air. The casing is fitted with easily removable discs at each end, which give access to both ends of the heating rods so that these may be easily fitted and replaced when necessary.

The "LT.11" furnace is suitable for two heating rods, whilst the "LT.12" furnace will accommodate four rods and so give quicker heating up. Since these two furnaces are otherwise identical the power input per rod required to maintain the maximum temperature is smaller in the case of the latter and, therefore, the rods will have a longer active life. Both forms of furnace are identical in outward appearance. With the four-rod units rated at 2kW the heating up time to 1000 deg. Cent. is four minutes; it takes sixteen minutes to reach 1400 deg. Cent. With only two rods these times are sixteen and seventy minutes respectively.



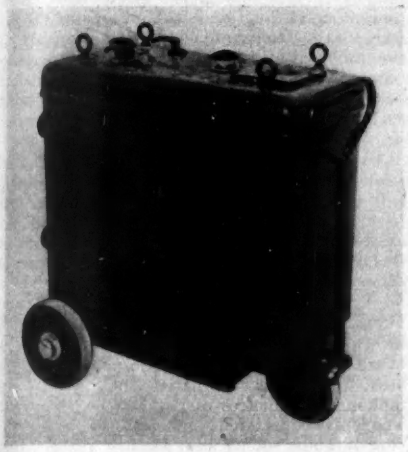
ELECTRIC FURNACE FOR TEMPERATURES UP TO 1400 DEG. CENT

EDIBLE OIL REFINERY.—On Tuesday of last week the foundation stone of a new edible oil refinery was laid at the Stork margarine works of Van den Berghs and Jurgens, Ltd., at Bromborough, Cheshire. When completed, the production from the new refinery will increase the potential output by 50 per cent.

450 Ampere Single Operator Welding Transformer

We have received particulars of a 450-ampere single-operator portable transformer welding set introduced by the Quasi-Arc Company, Ltd., Bilston, Staffs.

The set, which is illustrated herewith, consists of an oil-immersed transformer and regulator designed for welding duty to B.S. 171/1936 and B.S. 638/1941. Two ranges of output current can be obtained—50A to 450A at 80V open circuit, and 65A to 360A at 100V open circuit, the open circuit voltage being set at 80V or 110V by a centrally-mounted switch, which automatically limits the welding current output to a predetermined figure. Within either current range, the value of the welding current can be varied through the medium of two current selector roller switches, giving



"A.C.P. 450" PORTABLE WELDING TRANSFORMER

seventy-nine current settings. To enable the welding set to be connected to any mains supply between 175V and 550V, the input side of the transformer has twenty-four voltage tappings. The set is rated to give a continuous output (B.S. 171) of 18kVA and a maximum welding output of 36kVA. It is designed to satisfy the trend towards the use of heavier electrodes and the makers state that rods up to $\frac{1}{4}$in in diameter can be deposited speedily and economically.

The A.C.P.450 welding set, as illustrated, is mounted on three solid rubber-tyred pressed-steel wheels, of which the front wheel is recessed and can be steered by the towbar. The equipment includes cable connections, cable reel, lifting eyebolts and tool locker.

Variable-Speed Pulley

Some modifications and improvements have now been incorporated in the Druce-Elliot variable-speed unit (made by the Package Sealing Company, Ltd., Essex Road, Acton,) which was described in The Engineer, April 4, 1951, page 486. The improved unit is more robust, being constructed of cast iron with the sliding surfaces ground to a precision finish. The sizes of the bases have been altered and the range of adaptability extended. Unit No. 0 will accommodate fractional horsepower motors up to $\frac{1}{2}$ h.p., while No. 4 will accommodate a 75 h.p. motor.

Both belt tension adjustment and belt replacement have been improved and simplified. In the case of the former, the improved unit is fitted with a cam bar which has a micrometer adjustment, while the belt is replaced simply by unslackening the two clamping screws on the side of the bracket. Another improvement is contained in the multi-groove pulley permitting a drive from vee to vee instead of merely from vee to flat as hitherto.

A further development in the company's range of variable-speed drive equipment is the new variable-speed countershaft. This unit consists of a cast iron base surface ground to close limits, together with two Druce-Elliot pulleys mounted on a common shaft running in two ballrace plummer blocks. Pulley distances are controlled by a handwheel which, when moved in a clockwise direction, causes the countershaft base to move angularly towards the operator. This operation, in turn, opens one of the pulleys simultaneously closing the other pulley. Thus, speed variations of up to 20 to 1 are possible.

American Engineering News

(By our American Correspondent)

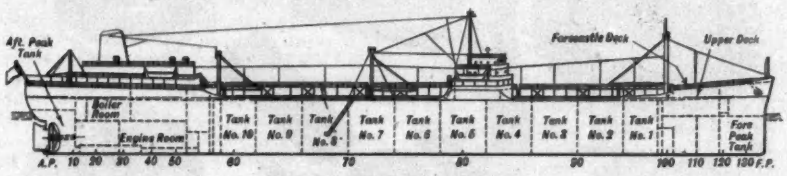
The Construction of Super-Tankers

The continuing trend to the adoption of "super-tankers" by oil companies all over the world is illustrated by some interesting details relating to several such vessels which are now being built at the Chester yards of the Sun Shipbuilding and Drydock Company. Their principal characteristics were determined on a basis of fulfilling the following service conditions stipulated by the oil company: (1) to be capable of making shipments of crude oil of 33 deg. A.P.I. gravity, from the Middle East to Marcus Hook, Pennsylvania, with adequate round trip bunkers; (2) to be capable of making shipments of petrol in the domestic trade from the Pacific Coast and Gulf ports to Marcus Hook, Pennsylvania; (3) draught limitations to enable transit of the Suez Canal (34ft maximum) and docking at Marcus Hook, Pennsylvania; (4) tank capacity to be adequate to hold 63 deg. A.P.I. light gravity petroleums for the maximum available cargo deadweight. When carrying the 33 deg. A.P.I. crude oils the required tank space for the maximum cargo deadweight is less than when carrying 63 deg. A.P.I. petrol, and the aftermost cargo wing tanks can be used as reserve bunkers to add to the fuel supply on the voyage to the Middle East and return. The principal characteristics of these vessels are as follows:—

Length, overall	641ft
Length, between perpendiculars	615ft
Breadth, moulded	84ft
Depth, moulded	45ft
Design draught, keel	34ft
Cargo oil capacity, 100 per cent full	250,600 barrels
Fuel capacity, 100 per cent full	1,345 tons
Reserve fuel, forward, 100 per cent full	1,890 tons
Gross tonnage (estimated)	18,750
Trial speed	16½ knots

The general arrangement of these vessels is shown in the accompanying profile diagram. They are of the three-island design—poop, set-in bridge and forecastle, with a straight raked stem, cruiser stern and single continuous steel deck. The tankers will be propelled by a single screw, with the conventional location aft for the propelling machinery, consisting of geared turbines and two water-tube boilers. The main cargo pump room will be situated at the aft end of the cargo oil space. The cargo tank space will be divided transversely into two wing tanks and a centre tank by two longitudinal oil-tight bulkheads. Longitudinally there will be ten subdivisions by transverse oil-tight bulkheads, making a total of thirty cargo oil comparments. Generally, the tanks will be 39ft 4in long and the overall length of the oil space will be 380ft. The principal dimensions and characteristics of the vessels were selected to provide a suitable, easy-driving hull form. Experience has shown that the "super-tankers" have a tendency to plough through the North Atlantic waves rather than rise up to them, and accordingly the form forward has been given a decided flare in order to throw off the green seas. The vessels will have a flat sheer line, and the forecastle and poop will be raised at the ends of the vessel to give a sheer effect, and thereby contribute to the seaworthiness. To give added protection, solid bulwarks will be fitted for 40ft aft of the forecastle. To provide adequate longitudinal strength a length-to-depth ratio of 13·7 was selected. The determination of the depth was also predicated on the Load Line Rule Requirements to meet the design draught and to provide an adequate cargo volume for the petrol trade. With the proportions selected for length to beam, the vessels are expected to manifest easy rolling characteristics.

Each vessel will be propelled by a single, four-bladed, solid, bronze propeller, 22ft in diameter, of Slocum design. The screw will be driven by Westinghouse cross-compound, double-reduction, geared turbines, rated at 13,500 normal s.h.p. at 100 r.p.m. Three bleeder stages will take the steam extraction from the turbines. A flexible coupling will be used between the turbines and the reduction gears. The Westinghouse main condenser will be of the two-pass type, designed to maintain a vacuum of 28·5in of mercury. The



PROFILE OF SUPER-TANKER

two main boilers will be Babcock and Wilcox standard merchant navy, two-drum units, and will supply steam at a pressure of 600 lb per square inch gauge, at a total temperature of 840 deg. Fah. Each boiler will be fitted with four variable capacity oil burners. The boilers will operate on forced draught. The combined rated capacity of the boilers will be 105,000 lb per hour at normal rating. The feed water will be delivered to the boilers at 300 deg. Fah. by a three-stage feed-heating system.

Hazards from Static Electricity

A recent explosion in a New York hospital, which is believed to have been caused by a discharge of static electricity, has once more served to illustrate the serious hazards associated with static electricity. For many years, the National Bureau of Standards has been consulted by other Government agencies on problems arising from such hazards, and to meet a growing demand for this information the Bureau is at present enlarging its research and standardisation programme for establishing and evaluating methods of measurement and for determining the properties of materials and equipment used to reduce the hazard. The results of one important phase of the programme, an investigation of the conductivity of floor coverings, are already being utilised to reduce static electricity hazards in hospitals currently under construction and in Federal ordnance factories.

Specifications for conductive floors and other equipment depend on a determination of the safe limiting resistances between objects. The N.B.S. has participated in determining these limits, evaluating various safety factors, and devising suitable methods applicable to field as well as to laboratory testing of flooring and other materials, and is now testing and evaluating various forms of conductive floorings, coatings and waxes. It has been established that a "conductive" floor need be only a moderately good conductor of static electricity—a resistance of 1 megohm or less is ample for this purpose. Such a flooring provides a safe path over which separated electrostatic charges may be reunited as quickly as they were separated. It is this natural inclination of the charges to reunite rapidly that

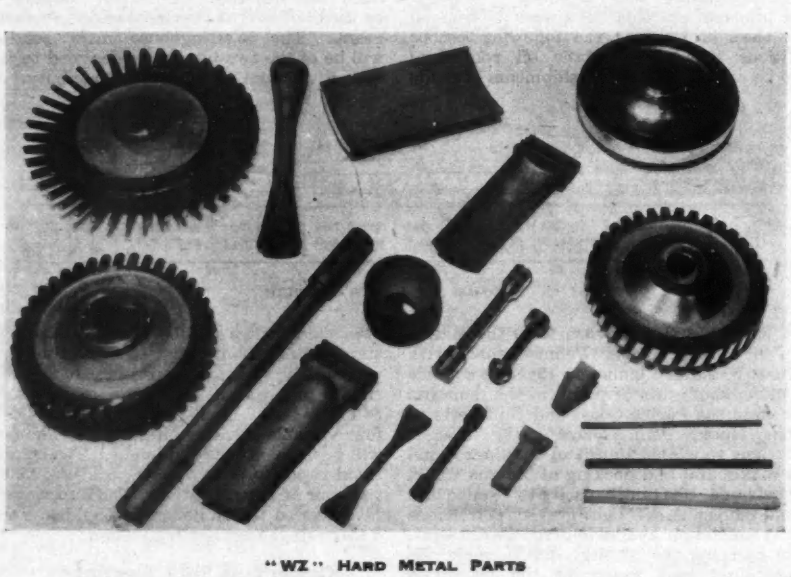
causes the hazard, creates the spark, or provokes the shock. To determine the resistance characteristics of flooring, a sample is subjected to different voltages under varying conditions of humidity and temperature. The flooring resistance is measured with a special resistance bridge as a function of pertinent variables such as voltage, humidity and the design of electrode used in making the measurement. One test on a section of terrazzo flooring showed that for a variation of from 30V to 500V, the resistance of the sample decreased from about 4·5 to 1·5 megohms. A low-resistance, flooring—conductive linoleum—changed from almost 3 megohms at 40V to less than 10,000 ohms at only 150V. An accompanying phase of these experiments is a determination of the actual safe upper limit of resistance. For example, tests have shown that voltages as high as 5kV can be developed by such common occurrences as getting up from a plastic-covered chair. Oscillographic records, however, indicate that if the resistance between the person and the chair is less than 20 megohms, the voltages will not exceed 300V. This is less than the minimum sparking voltage in air and is thus not hazardous.

The magnitude of the electrostatic charges produced by separating objects depends on the material involved, their intimacy of contact, and their surface resistivities. However, many accidents do not arise from these direct effects, but rather from the secondary effects resulting when the static electric charges are reunited. For instance, the electric shock experienced when a charged person touches a conducting object, while generally merely annoying, can cause serious damage if the person is precariously balanced on top of a ladder at the time he receives the minor shock. Also, the energies in electrostatic sparks may be large enough to ignite inflammable gases or vapours that may be present in an enclosed room. Likewise, the "precipitation static" caused by corona discharges from highly charged aircraft in flight has been found to be often responsible for very serious interruptions to radio communications. The most serious hazards—those of possible ignition of inflammable gases or dusts—can best be mitigated by reducing the inflammability or eliminating exposure to the inflammable agent. These measures, when combined with the exclusion from the area of materials such as plastics, wool and rubber, which have high electrical resistivity and "generate" high electrostatic charges, are generally considered sufficient to reduce the hazard to a negligible value.

More elaborate methods of mitigation depend upon reuniting the charges as fast as they are separated in order to keep the voltage across the affected objects low. This can be accomplished by connecting stationary metallic objects to a common ground, by humidification, which provides a film of moisture of moderate conductivity on most objects, or by installing a conductive floor to provide electrical contact with the objects which move or rest upon it. The latter is generally considered the safest method where persons or moving objects may separate charges. Thus, in hospital operating rooms, for instance, the personnel normally wear shoes with conductive rubber soles, and the floors are made of conductive material. The separated charges developed in a person by walking, rising from a chair, or removing sheeting are then quickly reunited through the flooring before they can be transferred to another person or object.

New High-Temperature Material

At a recent meeting of the American Institute of Mining and Metallurgical Engineers in New York, Dr. Paul Schwarzkopf, president of the American Electro Metal Corporation, Yonkers, New York, announced an interesting high-temperature material, which is believed to be superior to the so-called super-alloys used at present. The material represents a cemented carbide hard metal; the main constituent is titanium carbide, while corrosion-resistant chromium-cobalt and chromium-nickel alloys are used as binder metals. According to Dr. Schwarzkopf, the density ranges between 6·1 and 6·5 and the hardness between 81 and 87 on the Rockwell A scale, depending on the amount and composition of the binder metal. The material is said to be oxidation resistant; the weight gain, after exposure in air at about 1000 deg. Cent. for 100 hours, amounts to from 2 milligrammes to 5 milligrammes per square centimetre. The heat shock resistance of the material is considered satisfactory. Its transverse rupture strength values at room temperature vary from 175,000 lb to 225,000 lb per square inch, and those at 1000 deg. Cent. from 125,000 lb to 150,000 lb per square inch. The 100-hour value of the stress-to-rupture strength at 1000 deg. Cent. is about 14,000 lb per square inch. The accompanying illustration shows various parts made of the new material, including complete turbine rotors and individual turbine buckets. In co-operation with a firm of gas turbine manufacturers, a one-piece turbine wheel is now being developed to fit an engine with an overall diameter of about 15in and a length of about 3ft 6in, which is expected to develop 350 h.p. at 40,000 r.p.m. The heat-resistant titanium carbides described were developed initially at the Metallwerk Plansee, Reutte, Austria, under the trade name "WZ." The materials will also be produced in the United Kingdom by Metro-Cutanit, Ltd., under the trade name "Elmet-HR."



"WZ" HARD METAL PARTS

French Engineering News

(By our French Correspondent)

The greater use of diesel locomotives by French railways is being examined. At the moment France has about 250 diesel locomotives but with two exceptions they are all used for shunting or on unimportant lines. There are no large diesel locomotives in France but both the railways and private industry use many small shunting engines of about 150 h.p. The view engineers are taking is that diesels are not uneconomic. They point out that France has to import 40 per cent of her fuel in some form or another. It is more economical, they think, to import diesel oil, with its high calorific value, than coal. In actual performance the diesel locomotive is also considered superior. At the moment there are between fifteen and twenty manufacturers of diesel engines in France. The railways could not import locomotives under present conditions and it is suggested, therefore, that attention should first be paid to the modernisation of French plant to make economic construction possible. Orders should be carefully planned, it is suggested, to make such modernisation worthwhile.

* * *

Two new companies have been formed to exploit oil in Southern Algeria. Prospecting will be carried on over two areas, the first covering 150,000 square kilometres and the second 240,000 square kilometres. Much of this ground has not yet been mapped and aerial survey work is now in progress.

* * *

The exploitation of natural gas at Cap Bon in Tunisia has been started. The gas was found as a result of oil prospecting in the area, and it is estimated that about 200 million cubic metres of gas can be recovered, which is considered sufficient to serve the city of Tunis for at least twenty years. Derricks have been erected and wells sunk to a depth of 2000m, and pipe-lines are being built to Tunis. This will make a considerable difference to the city, which in April, 1952, imported 20,477 tons of coal.

* * *

Work is now going ahead on the industrialisation of French Guinea, for the most part to exploit the iron and bauxite there. The work includes the construction of a large hydro-electric scheme. The port of Conakry will be rebuilt. It is hoped that by the end of this year the first results will be noticeable as work in the country has already started. About £4 million is being invested at present.

* * *

Reports from Indo China say that the electricity position has improved there and that electricity production has increased, over the past year, by 32 per cent. This is quite remarkable considering that the country is constantly under the threat of sabotage. There have, however, been fewer incidents over the past year than during the previous twelve months. The dam at Uong-Bi, which feeds Haiphong with water and which was almost completely destroyed at the beginning of 1951, has not yet been repaired, but temporary measures have helped to meet the demand. Work on a new dam continues.

* * *

The S.N.C.M.A., one of the French State aircraft construction organisations, has announced the first trials of a new jet engine called the "Vulcain." It has a static thrust of 4500kg to 5500kg without after-burning, and is said to be one of the most powerful of its kind in the world. The first "Vulcain" prototype was given its trials on May 21st, which was just eleven months after the design had been approved. The short development time has been favourably commented upon.

* * *

A new continuous strip rolling mill will soon come into operation at Ebange for "Sollac," the French steel company. Altogether, seven companies are included in "Sollac." The aim is to produce about 1 million tons of strip metal by both hot and cold strip rolling methods.

Industrial and Labour Notes

Iron and Steel Production

Despite the Whitsun holidays, steel output in June was at a higher rate than in June last year. Figures issued last week by the British Iron and Steel Federation show that the production of ingots and castings averaged 312,500 tons a week, which represented an annual rate of 16,252,000 tons, compared with a rate of 16,245,000 tons in May and 16,007,000 tons in June last year. Over the first six months of this year the weekly average production of steel was 308,600 tons, and was thus at an annual rate of 16,046,000 tons, compared with 16,306,000 tons in the first half of 1951. Pig iron output in June averaged 199,700 tons a week, which indicated an annual rate of 10,384,000 tons, compared with a rate of 10,456,000 tons in May. In the first six months of this year pig iron output was at an annual rate of 10,397,000 tons, compared with 9,506,000 tons in the first half of last year. In presenting the figures, the British Iron and Steel Federation says that in recent weeks five new blast-furnaces have been brought into operation. After the necessary running-in period, pig iron output should benefit considerably from those furnaces.

Employment and Unemployment

According to the latest report from the Ministry of Labour on the employment situation in Great Britain, there was little change in the size of the total working population during May. At the end of the month the working population numbered 23,474,000 (16,045,000 men and 7,429,000 women). The number of people in civil employment at the end of May was 22,143,000 (14,960,000 men and 7,183,000 women), which was 9000 more than at the end of April.

Analysing the returns of civil employment in May, the Ministry states that there was a net gain of 20,000 in the labour forces of the basic industries, the total for those industries at the end of the month being 4,131,000. The principal increase was a seasonal one in agriculture. In coal mining the labour force continued to increase during the month and was returned as 717,000, compared with 698,000 at the end of last year. In the manufacturing industries, however, the total number of people employed declined by 45,000 during May, the biggest decrease being in the textile trades. In the "engineering, metal goods and precision instruments" group there was a decline of 7000, bringing the number of people at work in that group to 2,588,000. At the same time, 2000 were added to the vehicle building industries, making the number at work there 1,080,000. The number employed in all the manufacturing industries at the end of May was 8,623,000. The principal changes during May in the employment situation in other industries were an addition of 9000 to the labour force of the building and contracting industries, and an addition of 21,000 to the number engaged in "professional, financial and miscellaneous services."

Unemployment figures included in the Ministry's report relate to June 16th, when 440,054 people were registered as out of work, compared with 467,445 on May 12th. The June figure, the Ministry says, represented about 2·1 per cent of the total number of employees. The report adds that in the week ended May 24th, 304,000 operatives in manufacturing establishments in this country were reported to be on short time, losing seventeen hours each on the average. In the same week 1,159,000 people were reported to be working an average of seven and a half hours' overtime.

Non-Ferrous Metal Prices

The Ministry of Materials announced, at the end of last week, a reduction in the price of lead. From July 10th the price of imported good soft pig lead, delivered consumers' works, is £131 per ton. On the following day the Ministry stated that its buying price for rough copper in slabs of from 2 cwt to 3 cwt had been increased from £230 to £235 a ton.

An Order, made by the Minister of Supply, which came into effect on July 14th, increases the maximum prices of aluminium scrap, following the recent increase in the price of virgin aluminium. Subject to certain additions which the Order authorises in respect of bagging and special packing and for delivery at consumers' premises, the maximum prices per ton are now as follows:—New pure aluminium foil scrap for flake powder, £159; other pure aluminium scrap, £126; old rolled or extruded pure aluminium scrap, £115; clear aluminium alloy scrap, £109; aluminium alloy turnings, £81; new pure plain aluminium foil stock scrap, £152.

Britain's Overseas Trade

The provisional trade figures for June, which were issued at the end of last week by the Board of Trade, show that the value of exports of United Kingdom goods was only £185,000,000, a figure 18 per cent below that for the month of May. It is explained that, on account of the Whitsun holiday, June was a shorter month, with only twenty-three working days, compared with twenty-seven in May, but the Board of Trade says that that should only account for a reduction of about 15 per cent.

Exports in the second quarter of this year dropped in value to £628,000,000, compared with £718,400,000 in the first quarter, and were thus lower than at any time since the first quarter of last year. For the first half of this year the value of exports amounted to £1,346,400,000, compared with £1,339,700,000 in the latter half of last year; the volume of exports was probably slightly lower than last year.

Imports into this country in June have been valued provisionally at £276,700,000, which was 14 per cent lower than in May. For the first half of this year the value of imports was £1,903,300,000 compared with £1,856,400,000 in the corresponding period last year, and with £2,057,800,000 in the second half of last year. The reduction in the first half of this year compared with the latter half of last year was due mainly to a fall in volume. Re-exports in June were valued at £8,300,000, so that the excess of imports over total exports was £83,400,000. For the first half of this year the excess was £471,600,000, compared with £655,500,000 in the second half of 1951 and £552,100,000 in the first half.

Wages and Prices

In the course of a speech at Exeter last Saturday, the Chancellor of the Exchequer, Mr. R. A. Butler, said that even at present price levels there was now keen competition in foreign markets for many of our exports. Capital goods from the engineering and electrical industries provided 30 per cent of this country's exports in the first quarter of this year and included many classes of machinery which were only just "holding their own." Since other countries had to pay about the same price for their raw materials as we did, wage rates were the decisive element in our export prices.

Any considerable rise in wages in the engineering industry, Mr. Butler continued, would result in a loss of many existing markets, not to speak of any hope of increasing engineering exports. The effect of a 10 per cent rise in the wages of engineering workers would lead directly to a rise of about 4 per cent in the cost of engineering products. General rises in wages, with their direct and indirect effects, the Chancellor claimed, would add a good deal more to prices. A rise of £1 a week for all workers would put up export prices by about 1s. 2d. in the pound, which would mean a damaging blow to large parts of the export trade. It was at this point, the Chancellor said, that a policy of full employment was put to its crucial test. If wage costs prevented the full realisation of the export programme, the resulting cuts in raw material imports—which would be inevitable—would risk unemployment or short-time working for some of the population.

It was not possible, the Chancellor added, to say exactly how much of the 13 per cent increase in retail prices between January, 1951, and January, 1952, was a result of higher wages. But certainly the rise of 10 per cent in earnings between October, 1950, and October, 1951, accompanied by a productivity increase of only about 1 per cent, must have played a major part.

The Coal Situation

The effect of the holiday season is now being reflected in the figures giving current coal production in Great Britain. Last week, output from the deep mines amounted to 3,840,400 tons, and from opencast workings 279,800 tons, giving a total of 4,120,200 tons. In the corresponding week of last year, the total output was 3,963,900 tons. Recognised holidays last week are estimated to have caused a loss of 371,500 tons of deep-mined coal. In the first twenty-eight weeks of this year, ended July 12th, total coal production amounted to 122,875,500 tons, or just over 2,000,000 tons more than in the comparable period of 1951.

The latest statistics issued by the Ministry of Fuel and Power indicate that colliery manpower is still increasing. In the week ended July 5th, the number of wage earners on colliery books was 719,000, of whom 294,900 were face workers. A year ago the number of men working at the face was 288,800. The shifts worked per wage-earner in the week ended July 5th, numbered 4·83, the output per man-shift at the face being 3·09 tons. In the same week, inland coal consumption was 3,438,500 tons, compared with 3,500,000 tons a year earlier. Of that amount, the requirements of industrial consumers were 700,000 tons, against 771,000 tons in the corresponding week last year. Exports and bunkers took up 321,000 tons of coal in the week ended July 5th, so that total consumption was 3,759,000 tons. The total distributed stocks at the end of that week were 16,491,000 tons, or about 4,000,000 tons more than on July 7, 1951.

Iron and Steel Distribution Scheme

A number of technical changes in the iron and steel distribution scheme have been announced this week by the Ministry of Supply. They take effect on Monday next, July 21st. The principal changes are that large springs have been taken off the directly controlled list, so that manufacturers incorporating springs in their products will need to give spring makers a sub-authorisation out of their main allocation; and the amount of electrical conduit which can be obtained without permit under the small quantities exemptions has been reduced to 3 cwt a month.

Relaxations have also been made in the special arrangements for economising in the use of alloy steels containing nickel and molybdenum. The direction to steel makers has been amended to add the following to the list of special-purpose steels not subject to restrictions: induction-hardening steels; any gun component steel to Ministry of Supply Specification S.56, or to Admiralty Specification E.52, E.53 or E.54; any steel to any Ministry of Supply I.F.V. specification or to any Admiralty specification being (in each case) a specification containing a ballistic test standard; armour-piercing projectile steels, torpedo steels; turbine blading steels; and steels prepared as a drawn wire in coil. These may now be used without permission from the Ministry of Supply's Director of Alloy Steel Control. The changes are authorised by the Iron and Steel Distribution Order (Amendment No. 2).

Notes and Memoranda

Rail and Road

LARGE RAILWAY WAGONS.—Two of the biggest wagons ever designed for use in this country have been ordered by British Railways for the transport of electrical equipment, such as transformers of exceptional weight and size. Each wagon will have twenty-four wheels, will be 92ft in length, and capable of carrying a concentrated load up to 135 tons. Traversing mechanism will be provided to enable such loads to be moved to either side of a wagon to pass fixed structures such as bridges, centre girders on bridges, signal posts, &c. These wagons, which will be built by Head, Wrightson and Co., Ltd., of Thornaby-on-Tees, are expected to be in service by the late autumn.

Air and Water

TRIPLE CEREMONY.—An interesting event occurred last week at the Belfast shipyard of Harland and Wolff, Ltd., when a keel-laying ceremony, a launching ceremony and the trials took place of three similar motor-driven oil tankers for the same owners. After witnessing the naming ceremony and the launch, the party saw the keel of a sister vessel being laid in an adjacent berth, and then joined the first completed ship for sea trials.

COASTAL MINESWEEPER.—H.M. Coastal Minesweeper No. 1 was launched on July 9th at the yard of John I. Thornycroft and Co., Ltd. This company is acting as the parent firm for the building of these vessels, which have a length of 152ft by 28ft 9in beam, and will be armed with three small guns. These minesweepers make use of aluminium alloys for framing and structural castings, and are planked with wood so that the hull is largely constructed of non-magnetic material, and they will be fitted with sweeping equipment for dealing with magnetic and acoustic mines.

NAVIGATION SYSTEM.—The Decca Navigator Company, Ltd., will extend the position information of shipping in North-West European waters when it opens its South-West British Chain of land radio transmitting stations on July 29th. The master station is at Bolberry Down, near Salcombe, and the three slave stations are situated as follows:—Red, at St. Helier, Jersey, Green, at St. Mary's, Scilly Isles, and Purple at Llancarfen, near Cardiff. With the addition of this new chain, the Decca system will cover an area extending from the Bay of Biscay to the Baltic, including the North Sea and English Channel.

AIR TRAFFIC FOR MAY, 1952.—Air transport movements at United Kingdom aerodromes in May, 1952, totalled 14,987, 3·5 per cent less than in May, 1951. Passengers handled totalled 226,371, an increase of 6·3 per cent. Freight on- and off-loaded at 3384·4 short tons showed a decrease of 14·4 per cent. Post Office Mail set down and picked up decreased from 1121·8 to 924·4 short tons. At London Airport there were 2666 air transport movements (a decrease of 11·8 per cent compared with May, 1951), and passengers handled totalled 71,415 (a decrease of 0·1 per cent). Northolt recorded 3469 transport movements, a decrease of 10·1 per cent, while passengers handled decreased by 4·1 per cent to 63,781. Airports at which passenger traffic increased considerably over May, 1952, were Prestwick, 12,968 (38·3 per cent increase); Manchester (Ringway), 11,288 (25·3 per cent increase); Isle of Man (Ronaldsway), 5859 (12 per cent increase); and Edinburgh (Turnhouse), 2287 (86·4 per cent increase). Jersey Airport handled 18,748 passengers, an increase of 44 per cent and Guernsey 8949, an increase of 20·6 per cent.

Miscellanea

ELECTRICAL ASSOCIATION FOR WOMEN.—The twenty-eighth annual conference of the Electrical Association for Women will take place on Wednesday, April 15, 1953. The annual general meeting and luncheon will be held at the Connaught Rooms, Great Queen Street, W.C.2, on that day.

LUBRICATING OIL PLANT.—The lubricating oil plant at the Dunkirk refinery, which is operated by the Societe Generale des Huiles de Petrole B.P., is now in production. It has an annual capacity of 55,000 tons, and after supplying the French and North African markets, the surplus will be available for the continental markets.

CANADIAN SULPHUR PLANT.—At Jumping Pound, Alberta, there has been put into service Canada's first plant to produce sulphur from petroleum. The plant, which is located in an oil-producing region, will have an initial annual output of 10,000 tons of sulphur of a high grade purity, extracted from hydrogen sulphide in the natural gas treated at an adjoining Shell plant. This domestic production of sulphur will assist Canada's economy and the sulphur will be used for treating wood fibre for papermaking.

I.E.E. ELECTIONS.—The Institution of Electrical Engineers has announced the election of Colonel B. H. Leeson as president for 1952–53. Mr. J. Eccles and Mr. T. E. Goldup have been elected vice-presidents. Newly elected members of the council are Dr. C. Dannatt, Mr. O. W. Humphreys, Mr. A. H. Mumford, Professor M. G. Say, Dr. H. R. L. Lamont, Mr. G. Lyon, and Mr. C. R. King.

SCOTCH DRY BACK BOILERS.—The Dominion Bridge Company, Ltd., Montreal, Canada, has issued a booklet giving details of the Scotch dry back boilers built by the company's boiler division. Arrangement drawings of both high pressure and low pressure designs are shown, and they are accompanied by the principal dimensions, set out in tabular form, of the range of boilers available.

CABLE FACTORY FOR NORTHERN IRELAND.—We learn from a statement by the Northern Ireland Minister of Commerce that the Wandleside Cable Works, Ltd. (a subsidiary of Falk, Stadelmann and Co., Ltd.), is to set up a new factory at Newcastle, Co. Down, for the production of electric cables. It is estimated that, in full production, the factory will provide work for about 180, of whom about two-thirds will be men.

CATALYTIC CRACKING UNIT.—The Houdry Process Corporation states that a Houdriflow catalytic cracking unit will be installed at the Antwerp refinery of the Albatross S.A. Belge pour le Raffinage de Petrole. The unit is of moving bed principle, and is designed for a daily capacity of 3600 barrels. Petrocarbon, Ltd., Manchester, is the consultant, and Head Wrightson Processes, Ltd., London, is responsible for the mechanical engineering.

COAL MILLING AND PULVERISED FUEL FIRING.—The subject of coal milling and pulverised fuel firing is dealt with in a well-illustrated twenty-six-page brochure (No. W 513) published by International Combustion, Ltd., 19, Woburn Place, London, W.C.1. This brochure describes various forms of mill—impact, ball and roll—and discusses mill drying, pulverised fuel firing, burner characteristics, tilting burners, furnace rating and proportions, ash discharge and gas flow. Sectional drawings of five modern power stations are included at the end of the text.

DETONATION OF FUEL VAPOURS.—We have received a copy of a report by Messrs. R. O. King and A. B. Allan, entitled "The Adverse Effect on Thermal Efficiency of the Endothermic Reaction required for Nuclear Ignition as shown by Engine Experiments with Methanol, Acetaldehyde and Diethyl Ether," which forms part of the work related to the oxidation, decomposition, ignition and detonation of fuel vapours and gases, carried out for the Defence Research Board of Canada, in association with the Department of Mechanical Engineering, University of Toronto.

CHEMICAL SOCIETY'S RESEARCH FUND.—The research fund of the Chemical Society provides grants for the assistance of research in all branches of chemistry. About £700 a year is available for this purpose, the income being derived from a donation of the Worshipful Company of Goldsmiths, from the Perkin Memorial Fund, and from other sources. Applications for grants will be considered in November next and should be submitted on the appropriate form not later than Saturday, November 15th next. The Society says that applications from Fellows will receive prior consideration. Forms of application, together with the regulations governing the award of grants may be obtained from the Chemical Society, Burlington House, Piccadilly, London, W.1.

ANGLO-SWEDISH TRADE TALKS.—The Board of Trade says that discussions between the United Kingdom and Swedish trade delegations have recently been concluded in London. The discussions have been mainly concerned with the difficulties which have arisen in regard to the issue of licences permitting the import of United Kingdom motor cars into Sweden and with the problems facing the Swedish paper and board industries owing to the restrictions on imports of paper and board into the United Kingdom. Both delegations have carefully examined the position in regard to imports of paper and board in the second part of this year, and licences for motor cars will now be issued for the second part of 1952 at the same rate as in the first part. Improved import facilities will be available for United Kingdom exports to Sweden in certain other cases.

Personal and Business

MR. H. A. SARGEAUNT has been appointed scientific adviser to the Army Council.

MR. G. B. PROCTOR, A.M.I.E.E., has been appointed managing director of Transformers and Welders, Ltd., Watford, Herts.

MR. M. K. SCHWITZER, A.M.I.Chem.E., has been appointed manager of the European chemical division of Amour and Company, Ltd.

BROOKS AND WALKER, Ltd., has established a branch office at Crichton House, Mount Stuart Square, Cardiff (Telephone, Cardiff 21491).

MR. W. E. FULLER has been appointed information officer in the research and development division of the British Steel Founders Association.

MR. W. M. WIDGERY, F.R.Ae.S., has been appointed technical director, and Mr. N. H. Payne, M.I.Mech.E., chief engineer, of Normalair, Ltd.

MR. ALAN KIERNAN, M.I.Mech.E., has been appointed assistant managing director of Edward G. Herbert, Ltd., Atlas Works, Levenshulme, Manchester, 19.

HIGGS MOTORS, Ltd., Witton, Birmingham, announces that its head office and works will be closed for the annual holiday from Friday evening, July 25th, until Monday, August 11th.

GEORGE KENT, Ltd., announces that Mr. F. R. Head has been appointed manager of its new Lea Works, Luton. He was formerly production controller at the firm's Biscot Road works.

WESTLAND AIRCRAFT, Ltd., states that Mr. D. L. Hollis Williams, F.R.Ae.S., has been appointed technical director in place of Mr. Arthur Davenport, F.R.Ae.S. Mr. Davenport continues to serve on the board of the company.

DR. W. I. PUMPHREY, M.Sc., manager of the research department of Murex Welding Processes, Ltd., Waltham Cross, has been made a Freeman of the City of London and a Liveryman of the Worshipful Company of Blacksmiths.

NIFE BATTERIES, Ltd., Redditch, states that its London sales office and railway signalling department have been transferred to 53, Victoria Street, S.W.1 (Telephone: Abbey 1412; telegrams: "Niandfe, Sowest, London.")

THE NATIONAL COAL BOARD has agreed to release Mr. Leslie O'Connor, its director-general of carbonisation, to take up an appointment on October 1st as deputy-chairman and director of the British Coking Association.

MR. R. C. CROSS has resigned his position as foundry manager and chief metallurgist of David Brown-Jackson, Ltd., to take up an appointment with Foundry Services, Ltd., in connection with that company's developments in South Africa.

SUNVIC CONTROLS, Ltd., 10, Essex Street, London, W.C.2, states that it is opening a continental office at Skindergade 38, Copenhagen K, Denmark. The company's continental manager, Mr. B. Hveissel, will be established at that address from August 15th.

WILD-BARFIELD ELECTRIC FURNACES, Ltd., Watford, announces that, in conjunction with its associated company, G. W. B. Electric Furnaces, Ltd., it has opened an office at 131, West Regent Street, Glasgow, C.2. Mr. D. McDermott is in charge of the office.

SANDERSON BROTHERS AND NEWBOULD, Ltd., Sheffield, states that, on account of ill health, Mr. H. T. Wordsworth has retired from the post of general manager, but will continue to serve on the board. Mr. J. R. A. Bull, formerly sales director, has been appointed managing director,

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., announces the retirement, at the end of this month, of Mr. A. G. Salisbury, of the motor engineering department of the Coventry works. Mr. Salisbury, who was a pioneer in the design of fractional horse power motors, joined the company as a special apprentice in 1904.

Contracts

MARCONI'S WIRELESS TELEGRAPH COMPANY, Ltd., has been awarded a contract, totalling about £100,000, for the design, manufacture and installation of equipment for a television service in Venezuela. The system will operate on the international standard of 625 lines, 50 c/s, and the equipment will consist of a 5kW vision transmitter, a 3kW sound transmitter, the associated aerial system and complete studio installation. The order also includes a mobile outside broadcasting unit with two camera channels and microwave links for relaying outside broadcasts to the studio.

British Patent Specifications

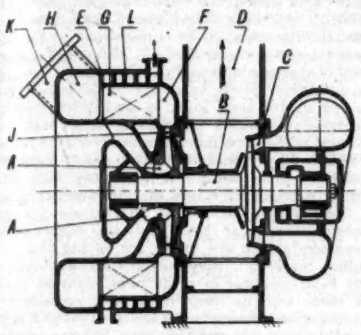
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

COMPRESSORS AND BLOWERS

674,689. May 24, 1950.—Cooling Means for Rotary Blowers, Societe d'Etudes de Machines Thermiques, of 7, rue Auber, Paris, France.

This invention relates to the cooling of rotary blowers for supercharging engines. As shown in the drawing, a centrifugal blower *A* is driven from a shaft *B*. The shaft is driven by an exhaust-gas-turbine wheel *C* integral with it, from which the expanded gas flows out through the exhaust stack *D*. Coaxial with, and surrounding the blower section is an annular air-outlet space *E*, internally



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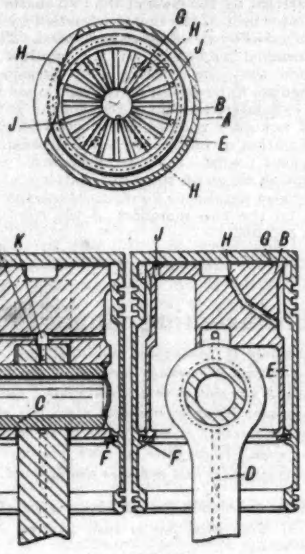
subdivided lengthwise into three serially disposed annular sections *F*, *G* and *H*. The first or upstream section *F* receives air direct from the discharge outlet *J* of the blower. The intermediate section *G* constitutes the cooling space proper, while the downstream section *H* is a discharge manifold and is connected at *K* with the air-induction manifold of the combustion engine. Surrounding the intermediate cooling section *G* is an annular water-jacket *L* comprising annular ducts for cooling water, the inlet and outlet ports being indicated by arrows.—*June* 25, 1952.

INTERNAL COMBUSTION ENGINES

674,367. February 28, 1950.—Fluid Cooling of Pistons, D. Napier and Son, Ltd., of 211, Acton Vale, London, W.3. (*Inventor: Ernest Edward Chatterton.*)

As illustrated, the piston comprises outer and inner parts *A* and *B*, the outer part being of tubular form and comprising a crown, a ring-carrying portion provided with ring grooves and a skirt portion. The inner part of the piston is of plug-like external form and is provided internally with a wide diametral web, the lower end of which is forked to provide two gudgeon pin bosses to receive the ends of a gudgeon pin *C* by which the connecting-rod *D* is connected to the piston. The annular chamber *E* is closed at the bottom by a circlip *F*, which engages with the lower flange. In the upper face of the part *B* is a crown-cooling chamber comprising an annular channel *G* lying adjacent to the circumference of the piston crown with a central pocket and a series of radial channels connecting the channel *G* to the pocket. Formed in the web are four oil transfer passages *H*, each of which leads from a point somewhat above the middle of the length of the annular chamber *E* into the central pocket, while four outlets *J* lead from circumferentially displaced points in the channel *G* into the open interior of the piston. The upper end of the connecting-rod *D* makes a substantially fluid-tight seal with a part of the web and has oil supply passages by which oil is fed to a collecting chamber *K* formed in this web and communicating with the annular chamber *E* by way of two oil delivery passages. During operation of the piston oil will be delivered either continuously under pressure or intermittently by momentum through the passages into the annular chamber *E*. The oil thus maintained in this chamber will be thrown between the ends of the chamber by the reciprocation of the piston, and when, during the last part of each upstroke of the piston, the oil is thrown into the upper end of the chamber *E* any surplus oil will be ejected into the pocket, thus ejecting a similar quantity of oil from the crown-cooling chamber through the outlets *J* into the open interior of the piston. A quantity of oil which is renewed substantially continuously during operation provides good cooling for the walls of the chamber, including the ring-carrying part of the piston, while the surplus oil is ejected into the crown-cooling chamber, where it effects



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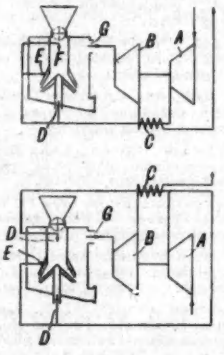
further cooling before being discharged into the open interior of the piston and thence finds its way into the engine crankcase or oil sump.—*June* 25, 1952.

GAS TURBINES

674,667. March 17, 1950.—Gas Turbine Plant, Maschinenfabrik Oerlikon, of Oerlikon, near Zurich, Switzerland.

The invention relates to a gas turbine plant comprising a combustion apparatus for solid fuels. The combustion apparatus shown in outline in the drawings consists of a fuel magazine with a furnace cooled by primary and secondary air and is fully described in the specification. In the upper view an air compressor *A* is mounted on the same shaft as a turbine *B*. The air issuing from the compressor is reheated in a heat exchanger *C* by the waste gases of the turbine. On issuing



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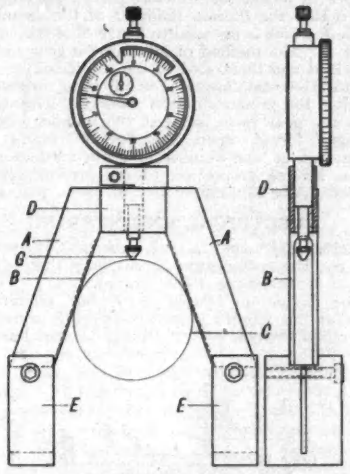
from the heat exchanger, the air is separated into two main parts—primary air *D* and secondary air, which is in turn, divided into two parts *E* and *F*. The primary air serves as combustion medium for the solid fuel, whilst the secondary air serves for cooling the walls, as combustion medium for the gases issuing from the fuel magazine and as a diluent for the hot gases before entering the turbine. The hot gases issuing from *G* are led directly into the gas turbine. In the lower view the air is divided into two streams on issuing from the compressor. The air for combustion of the fuel alone passes through the heat exchanger while the secondary air is led direct to the combustion apparatus.—*June* 25, 1952.

WORKSHOP TOOLS AND APPLIANCES

674,405. August 17, 1950.—"V" Gauge for Cylindrical Work, Georg Reicherter, of 35, Hindenburgstrasse, Esslingen (Neckar), Germany.

The invention relates to "V" gauges for testing irregularities in and the diameters of cylindrical work. The two bridge-connected legs *A* of the gauge are provided with measuring surfaces *B*, which contact the surface of the cylindrical work *C*. Arranged on the bridge *D* is a dial indicator *E*,



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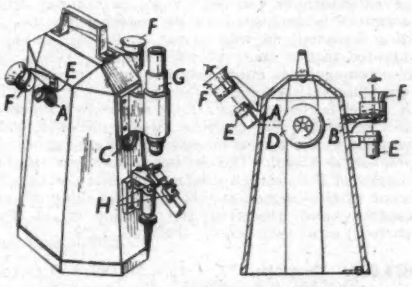
whose contact point rests on the work. Fastened to the free ends of the legs are weights *F*, which cause the centre of gravity to be located below the point *G* of the dial indicator. Thus the gauge remains in its position after being placed on the work, and the operator can take his hands off, with the result that a constant pressure is achieved for any kind of measurement.—*June* 25, 1952.

674,337. September 29, 1949.—Devices for Examining Diesel Engine Injectors, Leslie Hartridge, of Tingewick Road, Buckingham, Buckinghamshire.

As shown in the drawing, the device comprises a lamp-house having a flat base with a lifting handle. Light apertures *A*, *B* and *C* are provided whereby light from an electric lamp bulb *D* may be pro-



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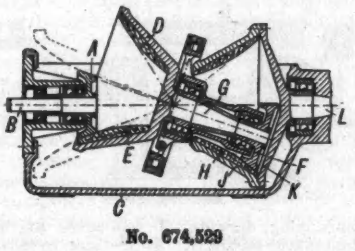
jected out. Mounted adjacent to the apertures are work holders with spring clips *E*. Optical magnifying means *F* are provided. For the examination of nozzle needles an alternative low-power microscope *G* is shown; it has a coarse sliding adjustment.—*June* 25, 1952.

POWER TRANSMISSION

674,529. February 22, 1950.—Gear for Varying Speed and Output, Oskar Hacker, of Hansi Niesegasse 18, Vienna XIX, Austria.

The invention relates to a gear for greatly varying speed and output. It comprises two pairs of friction members, each consisting of a hollow drum and a friction roller which revolves on the inside surface of the drum along optionally different diameters.



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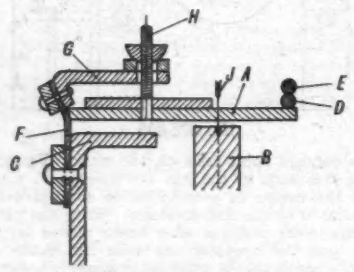
In the drawing *A* is a conical friction roller mounted on the driving shaft *B*, which is arranged in a trough-shaped gear case *C*. The friction roller *A* conveys the incoming power from the motor to

the gear, and contacts the conical friction surface of the hollow drum *D* by friction. The friction surface of this drum consists of a rubber lining *E*. The primary drum *D* is connected with the secondary roller *F* by its axle G. The secondary roller contacts by friction the friction lining *H* of the secondary drum *J*, which is fastened to flange *K* of the output shaft *L*. The method of altering the gear ratio is described and illustrated in the specification. The specification also illustrates an adjusting mechanism to alter the pressure of the rollers in conjunction with the gear ratio, so that the number of load changes forced upon the friction lining and dependent of the number of drum revolutions is in an inverse proportion to the pressure of the rollers.—*June* 25, 1952.

ELECTRICAL ENGINEERING

674,322. February 1, 1947.—SPRING MOUNTINGS FOR ELECTROMAGNET ARMATURES, Pierre Cibie, of 62, rue Haxo, Paris, France.

The invention relates to spring mountings, such as the vibrating contact-carrying armatures of voltage regulators. Referring to the drawing,



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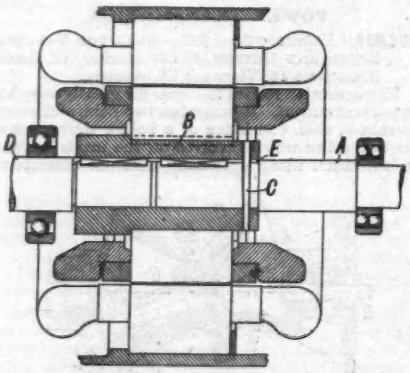
A is the armature, attracted by the core *B* in co-operation with the limb *C*, which partly closes the magnetic circuit of the electromagnet. It carries at one end the contact piece *D*, opposite the fixed contact *E*. These contacts must be closed when the electromagnet is not energised. The articulation of the armature upon the limb is obtained by means of a flat bent spring *F*, fixed to the limb *C*. On this spring is fixed a member *G*, bent so as to be substantially parallel to the armature. The armature is connected to the member by means of a threaded pin with a nut *H*, having a shape adapted to rest on a spherical seating. When the electromagnet is energised, the core attracts the armature with a force *J*, the lever arm of which is *K*, which is greater than *L*: the armature is lowered and separates the contacts, while its other end remains in the corner formed by the spring, which acts as a hinge. The initial adjustment of the tension of the spring by the nut permits the adjustment of the current at which the breaking of the contact (and therefore the cutting-off of the current) must take place.—*June* 25, 1952.

674,099. December 22, 1949.—MEANS FOR COUPLING MECHANISMS TO ELECTRIC MOTORS, Wright Electric Motors (Halifax), Ltd., of Century Works, Pellon Lane, Halifax, and Eric Clayton, also of the company's address.

The invention provides a method of effecting a coupling between a variable-speed mechanism, a reduction gear, or other mechanism, and an electric motor which reduces to a minimum any overhang of one part relative to the other. In the



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accompanying drawing, *A* represents the shaft of an electric motor *B*. At *B* there is shown a sleeve pinned or otherwise secured upon the shaft at *C*, the length of the sleeve being such that it projects, as shown, a suitable distance beyond the end of the shaft. *D* represents the shaft of a variable-speed mechanism, reduction gear or other mechanism to be coupled to and driven by the motor, the end of the shaft fitting, as shown, into the portion of the sleeve projecting beyond the end of the shaft *A*. The sleeve is provided with an internal longitudinal keyway *E* into which fit keys and carried by the ends of the two shafts *A* and *D*. The rotor unit of the motor is carried by the sleeve *B* instead of by the shaft *A* as is usual. The shaft *D* is journalled in a bearing and the length of the sleeve is such that the bearing and consequently the mechanism to be driven by the motor can be located very close up to the end of the motor. The arrangement not only enables the overall length of the combination or unit to be reduced considerably as compared with the arrangements previously employed, which for some installations is important, but it also reduces to a minimum relative overhang between the two members of the combination.—*June* 18, 1952.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

British Association for the Advancement of Science

Wed. to Wed., Sept. 3rd to 10th.—Annual Meeting in Belfast.

International Machine Tool Exhibition

Wed. to Sat., Sept. 17th to Oct. 4th.—Olympia, London.

Manchester Association of Engineers

Sat., July 19th.—Visit to Messrs. Cammell Laird's Shipyards, Birkenhead, 2 p.m.

Catalogues

HOLMAN BROTHERS, Ltd., Camborne.—Catalogue "81," illustrating a pneumatic concrete compactor.

QUASI-ARC COMPANY, Ltd., Bilston, Staffordshire.—Illustrated folder giving details of the twin-arc process.

PARKER FOUNDRY (1929), Ltd., "Troperas" Steel Works, Derby.—Brochure describing the activities of the Parker foundry.

STEELS ENGINEERING PRODUCTS, Ltd., Crown Works, Sunderland. Illustrated brochure of "Electric Eel" trucks and tractors.

THE RHEOSTATIC COMPANY, Ltd., Slough.—List No. 16 of "Satchwell" photo-electric protective device for oil burners, type "PER."

MULLARD, Ltd., Century House, Shaftesbury Avenue, London, W.C.2.—Book entitled *Valves and Tubes for Industry and Communications*.

BAKELITE, Ltd., 18, Grosvenor Gardens, London, S.W.1.—Booklet describing the types and grades of Bakelite phenolic moulding materials.

W. H. HEYWOOD AND CO., Ltd., Bayhall Works, Huddersfield.—Catalogue illustrating patent glazing and the thermal insulation of buildings.

INTERNATIONAL COMBUSTION, Ltd., 19, Woburn Place, London, W.C.1.—Survey of Poole generating station steam-raising and coal-handling plant.

GENERAL REFRACTORIES, LTD., Genefax House, Sheffield, 10.—Leaflet giving details of "Amberlite" insulating bricks for "Hot-face" insulation.

J. A. CRABTREE AND CO., Ltd., Lincoln Works, Walsall, Staffs.—Illustrated price list No. 193 of electrical wiring accessories and switch and fuse gear.

WESTINGHOUSE BRAKE AND SIGNAL COMPANY, Ltd. 82, York Way, King's Cross, London, N.1.—Illustrated booklet entitled *A.C. to D.C. by Metal Rectification*.

LANCASHIRE DYNAMO AND CRYPTO (MFG.), Ltd., Trafford Park, Manchester, 17.—Brochure showing pictorially a few aspects of "behind the scene" activity at L.D.C. Works.

HACKBRIDGE AND HEWITTIC ELECTRIC COMPANY, Ltd., Walton-on-Thames, Surrey.—Publications dealing with Hackbridge current-limiting reactors and Hewittic mercury vapour lamps for photographic copying.

STANDARD TELEPHONES AND CABLES, Ltd., Warwick Road, Boreham Wood, Herts.—Booklets giving details of low-tension rectifiers; low-current tubular rectifiers; single and three-phase medium-current rectifiers, and high-voltage power cable test equipments.

FOUNDRY SERVICES, Ltd., Long Acre, Nechells, Birmingham, 7.—Leaflets dealing with spray guns, corfixes, terracotes and lomags. Brochures of Foseco products for iron and steel, and for copper and nickel and their alloys. A list of principal products, and a list of Foseco representatives overseas.

ENGLISH ELECTRIC COMPANY, Ltd., Queen's House, Kingsway, London, W.C.2.—Illustrated booklet dealing with steam turbine plant of 5000kW and above; folder giving details of the air-blast circuit breaker, frame "G," and a leaflet giving details of flameproof battery locomotives for underground main haulage.

Technical Reports

The Lighting of Office Buildings. Ministry of Works' Post-War Building Studies, No. 30. H.M. Stationery Office. Price 3s. 6d.—This report, prepared by the Lighting Committee of the Building Research Board of the Department of Scientific and Industrial Research, follows an earlier report (No. 12 in the same series) by the same committee which dealt with the general principles of lighting and their application to dwellings and schools. The present report recommends standards for natural and artificial lighting. For natural lighting a sky factor of 1 per cent is recommended at a point not less than 12ft inwards from the outer face of the wall, with a minimum sky factor of 5 per cent for drawing-offices; a method of determining standards is described. For artificial lighting, the recommended values are of the order of 20 lumens per square foot for bookkeeping, typing, computing machine work, filing and general office work; for drawing-offices, 30–50 lumens per square foot; for private offices, 15 lumens per square foot; for inquiry and reception rooms, crush and entrance halls, 6 lumens per square foot. It is noted, however, that persons over forty may require higher values because "especially from the fourth decade onwards, the illumination level necessary to facilitate close work rises progressively." Results of a special survey of representative offices throughout the Kingdom, published as an Appendix to the report, show that one in five staff work in inadequate daylight. Furthermore, about 7 per cent of office staff work in rooms without windows, and of the remainder more than 20 per cent receive no direct light from the sky on their work. In a chapter on artificial lighting, account is taken of "discomfort glare" and "disability glare," due to extreme contrasts between the visual task and the surroundings. Recommendations are made for easing the strain on office workers; they include the avoidance of sharp local changes in brightness, such as from a dark desk top, or very dark wall colours; the positioning of lighting units for the better distribution of downwards and sideways lighting, and the use of light furniture and skilful decoration.

Launches and Trial Trips

FOURAH, motor tug; built by Henry Robb, Ltd., for the Crown Agents for the Colonies; length between perpendiculars 110ft, breadth 30ft, depth 14ft 6in, mean draught 10ft 9in, salvage and buoy lifting equipment; two British Polar diesel engines, total b.h.p. 1000 at 210 r.p.m. Trial, June.

WORLD CONCORD, oil tanker; built by Vickers-Armstrongs, Ltd., Barrow, for World Tankers Corporation, Liberia; length between perpendiculars 625ft, breadth moulded 86ft, depth moulded 45ft 9in, deadweight 31,000 tons, sea speed 15 knots; thirty cargo oil tanks, one pump room; one set of double reduction geared turbines of 12,500 s.h.p. at propeller speed of 100 r.p.m. take superheated steam from two boilers. Trial, June 26th.

DAGLAND, oil tanker; built by Swan, Hunter and Wigham Richardson, Ltd., for Aktieselskabet Ocean, Norway; length between perpendiculars 500ft, breadth moulded 65ft 6in. depth moulded 37ft 6in, deadweight 15,000 tons; load draught 29 ft 1 in, service speed 13 knots: Wallsend-Doxford two-stroke oil engine, five cylinders, 670mm diameter by 2320mm combined stroke, 5100 b.h.p. at 105 r.p.m., two multitubular boilers. Launch, July 7th.

FLOWERGATE, cargo liner; built by the Burntisland Shipbuilding Company, Ltd., for the Turnbull Scott Shipping Company, Ltd.; length overall 441ft 3in, breadth 56ft 8in, depth moulded to shelter deck 38ft 3in, draught loaded 25ft 9¼in, deadweight 9450 tons; five cargo holds, derricks include one of 25 tons; Kincaid-Harland and Wolff-B. and W. two-cycle, single-acting diesel engine, four cylinders 620mm diameter by 1870mm combined stroke, 3300 b.h.p. at 125 r.p.m., two multi-tubular boilers. Trial, July.

JANOVA, oil tanker; built by Harland and Wolff, Ltd., for Anders Jahre and Co., Norway; length between perpendiculars 540ft, breadth moulded 73ft, depth moulded 39ft 3in, deadweight 18,500 tons; one Harland-B. and W. two-cycle, opposed-piston engine, six cylinders, 750mm diameter by 2000mm combined stroke, 114 r.p.m. Launch, July 8th.

STYLEHURST, cargo ship; built by Swan, Hunter and Wigham Richardson, Neptune Works, for the Grenehurst Shipping Company, Ltd.; length between perpendiculars 435ft, breadth moulded 60ft, depth moulded to shelter deck 39ft, gross tonnage 5750; Swan, Hunter-Doxford oil engine, four cylinders, 670mm diameter by 2320mm combined stroke, 4400 b.h.p. at 115 r.p.m., two cylindrical boilers. Launch, July 8th.